SCIENCE

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE TEACHING OF CHEMISTRY IN AMERICAN AGRICULTURAL COLLEGES[1]

THE collection of statistics is very difficult. One special difficulty in connection with the subject which I have selected is due to the number and kinds of courses in the American agricultural college. This paper will be confined to two phases of chemistry in the agricultural college, viz., (1) the chemical instruction which is given to those who are preparing for agriculture, and (2) the opportunities afforded in these institutions for the preparation of students for careers in agricultural chemistry. With this purpose in mind we must omit all consideration of the various engineering courses in these institutions. We must omit from consideration also the various short agricultural courses and the courses in the agricultural colleges for negroes, as the chemical work in both cases is generally below the usual college grade and the consideration of either would of itself furnish sufficient material for a paper. These exclusions leave us the agricultural and the chemical courses. We shall first consider the four-year agricultural course. There are complications even here on account of the large number of electives which in effect give us several courses, such as in general agriculture, agronomy, horticulture, forestry, dairying, veterinary science, domestic economy, botany, etc. As we can not discuss all of these, the matter which we have collected is from one four-year course in each agri-

[1] Presidential address before the Association of Official Agricultural Chemists. Read at the twenty-seventh annual meeting in Washington, D. C., November 11, 1910.

cultural college, and this is the course in general agriculture, or agronomy. The chemistry which we consider in these is the minimum requirement. In the second part of the paper we shall consider the maximum chemical instruction which it is possible for one to receive in these colleges.

Another difficulty which confronts us is the great variety in the different institutions in the method of expressing requirements. In some cases there are given separately the requirements for the class room and for the laboratory in actual hours a week. In some cases the laboratory work is calculated to an equivalent of class-room work and in other cases the class work is calculated to an equivalent of laboratory work, and the two are expressed jointly. Even in this case there is no uniformity, as two hours, two and a half hours and three hours, in different institutions, are taken as the equivalent of one class-room hour. In some cases the actual number of hours is given, not as for the week, but as the total actual hours for the term, the term being the third, or the half year. The unit system is followed in many institutions, and is not uniform, referring in some cases to the third, the half or the whole year and varying in its representation from one to five hours a week. To make a comparison it is necessary to reduce these requirements to a single standard. The one selected is total class-room hours a week for the year, laboratory work being calculated to class-room work, and two hours of laboratory work being taken as the equivalent of one hour of class-room work.

The requirements for admission vary very much, and thus make great differences in the grade of work. For example, in some cases mathematical study begins in the freshman year with algebra, in others with plane or solid geometry, in others with trigonometry and in others all the mathematical study is required for entrance. Expressed by the Carnegie Foundation scale, the variation is from two or three points to about fourteen. The classification of states followed is that used by the Bureau of Education and other governmental departments.

GENERAL CHEMISTRY

In all the North Atlantic states (nine) general chemistry begins in the freshman year and in one state it continues two years. The number of hours a week given to the subject ranges from $2\frac{1}{2}$ to $5\frac{3}{4}$, the average being 4.

In the South Atlantic states (eight), four begin the subject in the freshman year, four in the sophomore year and in one the subject continues through the second year. The number of hours a week varies from 3 to $7\frac{1}{3}$, the average being 4.7.

In the north central states (twelve) all but two begin the subject in the freshman year and in one state it continues through the second year. The number of hours a week varies from 2 to $5\frac{1}{2}$, the average being 3.6.

In the south central states (eight) all but two begin the work in the sophomore year and in two it continues through the second year. The number of hours a week varies from $1\frac{1}{2}$ to 6, the average being 4.6.

In the far western states (eleven), excepting one, the information in regard to which is not available, one requires chemistry for admission, in seven the subject is begun in the freshman year, and in two in the sophomore year. In one it is continued the second year. The number of hours a week varies from $2\frac{1}{2}$ to 8, the average being 4.2.

By groups the hours a week vary from 3.6 in the north central states to 4.7 in the south Atlantic states, the average for the United States being 4.2. In one state gen-

eral chemistry is required for admission, in 32 the study of it begins during the freshman year, and in 14 during the sophomore year, and in 6 it continues through the second year. Without a single exception laboratory work accompanies class-room instruction.

ORGANIC CHEMISTRY

Organic chemistry is the branch of the subject which seems to be the least appreciated by those who have fixed the requirements of the course. Of the north Atlantic states three require the subject, in the south Atlantic states five, in the north central states four, in the south central states three and in the far western three, making a total of eighteen, or only a little more than a third of the states. Where given the number of hours a week varies from $1\frac{1}{3}$ to 5, the average, including those in which it is not given, being one. It is quite likely that in addition to this a little time is given to the subject in connection with the introductory courses.

Agricultural chemistry, the first of the agricultural sciences, in point of time, may be said to date from 1840 if any definite date can be assigned. The work which brought it into existence was prepared at the request of the chemical section of the British Association for the Advancement of Science. In the 1852 revision of Liebig's work by Lyon Playfair, the editor says, "the former edition of this work was prepared in the form of a report on the present state of organic chemistry." The title was "Organic Chemistry in its Application to Vegetable Physiology and Agriculture." When the second part of his report—that relating to animal physiology and pathology—appeared in 1852, Liebig said, "The connection between chemistry and physiology is the same [*i. e.*, 'so fused'—W. A. W.] and in another half century it will be found impossible to separate them." How could he know that about 1902 our knowledge of the carbohydrates and proteids and their cleavage products would have advanced so much! Will the agricultural colleges, while so highly honoring the memory of Liebig, at the same time minimize the subject, the knowledge of which made Liebig's work possible.

ANALYTICAL CHEMISTRY

Qualitative analysis is required in all the north Atlantic states but three, in all the south Atlantic states, in all the north central states but two, in all the south central states but two, and in all the far western states but one, making a total of only eight states in which it is not required. Quantitative analysis is required in two north Atlantic states, four south Atlantic states, four north central states, two south central states and four far western states, making a total of sixteen states or about one third in which quantitative analysis is required.

The average number of hours a week given to qualitative and quantitative analysis together is 1.5 for the north Atlantic states, 2.3 for the south Atlantic states and north central states, 1.4 for the south central states and 2.7 for the far western states, with an average of 2 for the entire United States.

AGRICULTURAL CHEMISTRY

As taught to agricultural students, agricultural chemistry appears upon examination of the college catalogues to have three different meanings, viz: (1) general chemistry, with such omissions and additions as will better fit the subject to the needs of agricultural students; (2) quantitative analysis, with its scope similarly modified, and (3) the consideration of plant and

animal nutrition, the substances involved in these processes and their products—useful and waste. The time spent along the lines mentioned first and second is included in this paper under the heads of general chemistry and quantitative analysis, which have already been discussed. The time spent upon what is generally called agricultural chemistry averages 1.6 hours a week for a year in the north Atlantic states, 1.7 in the south Atlantic states, 1.6 in the north central, 0.8 in the south central and 2.0 in the far western states, with an average of 1.5 for the whole United States. This average includes those institutions in which it is not required of agricultural students. The subject is not given at all, or is not required, in five north Atlantic states, in one south Atlantic state, in four north central, three south central, and four far western states, making a total of seventeen states in which it is either not taught at all or not required. This is probably due to the fact that the matter which was formerly included under the term agricultural chemistry and taught by the chemistry department is now, in many cases, taught by other departments under the names soils, fertilizers, plant nutrition, animal feeding, etc. The lines, representing the division of this work between the husbandry departments, do not seem to be very clearly drawn. For example, we find that a certain well-known text-book is used in some institutions in the chemistry department for agricultural chemistry and in others by the agronomy department for soils. This condition of things will in time probably adjust itself in the best way.

A summary of these findings is included in the following table:

NUMBER OF INSTITUTIONS REQUIRING CHEMISTRY IN THEIR AGRICULTURAL COURSES

Groups	Inorganic	Organic	Analytical	Agricultural
North Atlantic...	9	3	6	4
South Atlantic...	8	5	8	7
North central.....	12	4	10	8
South central.....	8	3	6	4
Far western.....	10	3	9	7
Total.....	47	18	39	30

CHEMICAL REQUIREMENTS IN AGRICULTURAL COURSES EXPRESSED IN HOURS A WEEK FOR A YEAR

	Inorganic	Organic	Analytical	Agricultural	Total
North Atlantic...	4.0	0.5	1.5	1.6	7.6
South Atlantic...	4.7	1.7	2.3	1.7	10.2
North central....	3.6	0.9	2.3	1.6	8.4
South central.....	4.6	0.6	1.4	0.8	7.4
Far western.....	4.2	1.0	2.7	2.0	9.9
Average.....	4.2	1.0	2.0	1.5	8.7

In 1897 the Committee on Methods of Teaching Agriculture reported to the Association of American Agricultural Colleges suggestions regarding a four-year course in agriculture. The matter relating to chemistry is as follows:

	Hours
Chemistry (class-room work)	75
Chemistry (laboratory work)	75
Agricultural chemistry, in addition to general requirement	180

Taking, as we have done, two hours of laboratory work as the equivalent of one hour of class-room work, and 36 weeks as the length of the college year, the recommendations of the committee of the college association would amount to the equivalent of 8.1 hours a week for a year, while the figures compiled by us show that an average of 8.7 hours is actually given.

The estimates by the committee of agriculturists as to what should be done and the average of what is actually done agree very closely indeed, and the truth must be somewhere near these two figures. The close agreement is all the more remarkable when we consider the great variation which we have in the different colleges. As time goes by we shall probably find the different

colleges conforming more closely to these averages.

UNDERGRADUATE WORK FOR CHEMISTS

The second portion of this paper relates to the opportunities offered by the agricultural colleges for training for chemical careers. Practically every agricultural college makes provision for such work, (1) by offering electives in the agricultural or scientific courses; (2) by grouping these electives so that beginning with the junior or senior year of the agricultural course a student may devote a large part of his time to chemistry, and (3) by offering four-year courses in chemistry or chemical engineering. The different catalogues show an ample number of electives, but unless there are fully organized four-year courses it is impossible to tell how many students avail themselves of their opportunities, and further consideration of them must be omitted.

The report of the Bureau of Education shows the following students enrolled in chemical engineering and chemistry in the various agricultural colleges for the year 1908–9.

State	Chemical Engineering	Chemistry
Maine	12	28
New Hampshire	19	
Vermont		33
Rhode Island	7	
New Jersey		12
Pennsylvania	11	65
North Atlantic states	49	138
Maryland		15
Virginia		34
North Carolina		17
South Carolina	9	
South Atlantic states	9	66
Ohio	34	
Indiana	51	19
Illinois	59	48
Wisconsin	23	41
Minnesota	15	46
Missouri	16	
North Dakota		4
North central states	198	158
Kentucky		25
Alabama		22
Louisiana	64	64
Texas	1	
Arkansas	55	55
South central states	120	166
Montana		4
Washington		18
California	51	
Far western states	51	22
Total for the United States	427	550

Total students in chemical engineering and chemistry in the agricultural colleges, 977.

This list does not show fully the undergraduate work for training chemists, but for the reasons stated above the data for fuller information were not available.

GRADUATE WORK IN CHEMISTRY

Practically every agricultural college has a few graduate students doing work in chemistry for the master's degree. This is a secondary feature in some of the colleges, and others have well-digested schemes for work. A very valuable paper showing the scope and extent of graduate work in America appeared in SCIENCE for August 19, 1910, entitled "Doctorates Conferred by American Universities." From that paper we learn that 178 doctorates were conferred for work in science in 1910, about one third of them by the universities of which the agricultural colleges are a part, and about two thirds by other institutions. Of this number 44 were in chemistry and about the same relation existed between the two classes of institutions. 15 doctorates for work in chemistry were conferred by Cornell, Illinois and Wisconsin. A table made from the paper referred to is inserted here, which shows among other things the very rapid development in the graduate departments of the universities of which the agricultural colleges are a part.

DOCTORATES CONFERRED IN THE SCIENCES[2]

	Average for 10 Years, 1898–1907	1908	1909	1910	Total for 13 Years, 1898–1910	In Chemistry, 1910
Cornell	10.4	15	24	27	170	4
Wisconsin	2.8	6	4	13	51	5
California	2.4	2	6	4	36	—
Nebraska	1.3	1	2	1	17	—
Illinois	0.3	0	2	9	14	6
Minnesota	0.7	1	2	1	11	—
Missouri	0.3	2	0	2	7	—
	18.2	27	40	57	306	15
Other universities	105.1	157	152	121	1,481	29
Total in America	123.3	184	192	178	1,787	44

AGRICULTURAL CHEMISTRY TEACHERS

Bulletin No. 224, of the Office of Experiment Stations, shows the organization of the different agricultural colleges in December, 1909. From this publication we find that there are 228 teachers of chemistry in these institutions who come in contact with the students in agriculture. This list does not include all the chemistry teachers, therefore. These are distributed approximately equally in the different sections except that the south Atlantic group has about half of her proportion, the deficiency being made up by the north central group. Of the 228, 51, or about one fourth have published enough research work to find a place in the "Directory of American Men of Science," 1906 edition. This publication, as is well known, contains brief biographical sketches of those who by research work have contributed somewhat to our store of knowledge. This is an average of a little more than one for each college. In number of teaching agricultural college chemists named in the Directory the north Atlantic and north central divisions lead, are about equal in numbers and together make about three fifths of the total number. The other groups are about equal and each has about half as many as each of the two groups first named. The larger proportion of names comes from the chemists in the south Atlantic division, it, out of a total of 24 chemists, having 9 names in the directory.

In the 1910–11 edition of "Who's Who in America" 31 find a place, or about one out of every 7 of the 228. This publication, now issued for the sixth time, contains the names of those who on account of their achievements in some directions have become subjects of more or less national interest. The greater number of agricultural college chemists, as in the case of the direcory, comes from the north central division which is followed closely by the north Atlantic division. These two together make up three fourths of the names, the other groups of states falling very far behind.

There is still another standard for comparison. The editor of the directory referred to has prefixed a star in his valuable publication to the names of about a thousand of those whose work is supposed to be the most important. Of the 228 chemistry teachers in the agricultural colleges whose names appear in the organization list prepared by the office of experiment stations, nine appear in the directory with a star. Five of these are in the north Atlantic and four in the north central groups. There are no starred names in the south Atlantic, south central or western divisions. These figures are shown in detail in the following table.

It may be interesting to see how the chemist in the agricultural college compares with his fellow chemist, when judged by the same standard. Information is lacking as to the exact number of chemists in America. There are 4,653 resident members of the American Chemical Society, and since many are not members of that society we know that there are more chemists than that number in America. If from this number we subtract 228, the number

[2] Compiled from SCIENCE, August 19, 1910.

CHEMISTS IN AGRICULTURAL COLLEGES, TEACHING AGRICULTURAL STUDENTS, WHOSE NAMES APPEAR IN

	Bull. 224 O. E. S.	American Men of Science	Who's Who in America	Starred Names in American Men of Science
North Atlantic states...	49	14	10	5
South Atlantic states ...	24	9	2	—
North central states.....	73	15	13	4
South central states.....	41	7	4	—
Far western states.....	41	6	2	—
Total in United States..	228	51	31	9

of agricultural college chemists, we shall have left 4,425. The non-agricultural college chemists furnish 168 starred names, or one name out of more than 31, while the agricultural college chemists furnish one starred name out of 25. This relative standing would be considerably increased were we to make correction for the number of chemists not members of the American Chemical Society. While it is doubtless a matter of pride that the agricultural chemist is assigned such high rank among American chemists by those who are considered by the editor of "American Men of Science" as the most capable judges, this fact should serve as a stimulus to greater effort.

W. A. WITHERS

ADDENDA.—Since the reading of the above address the second edition of Ameri-

AGRICULTURAL COLLEGE CHEMISTS

	Bulletin 224. O.E.S.	American Men of Science	Who's Who 1910–11	Amer. Men of Science. Starred. 1910
North Atlantic states...	49	19	10	6
South Atlantic states ..	24	12	2	—
North central states....	73	28	13	8
South central states....	41	13	4	—
Far western states.....	41	16	2	—
	228	88	31	14

can Men of Science has appeared. It shows that the Agricultural College Chemists have made a net gain of 38 names in the directory and 5 starred names. They have therefore not only maintained the relative rank previously assigned them, but have improved it. The distribution is shown by the revised table.

W. A. W.

BIOLOGICAL SURVEY OF THE PANAMA CANAL ZONE

A BIOLOGICAL survey of the Panama Canal Zone is about to be undertaken under the direction of the Smithsonian Institution. In connection with all of the preliminary government surveys for transcontinental railway routes, provision was made for biological studies, and at the time of the building of the Suez Canal a scientific commission was appointed to report on the facts pertaining to the natural history of that region. When the building of the Panama Canal was undertaken by the United States appeals were made by naturalists for the organization of a similar survey of the Canal Zone. It was found, however, that the officials in charge of that work felt that the actual labor involved was so great and the cost so enormous that it was unwise to divert time or money in any way from the single purpose of constructing the canal.

Under these circumstances, Professor C. H. Eigenmann, of the University of Indiana, induced various scientific bodies, including the International Zoological Congress and the American Association for the Advancement of Science, to address memorials to the Secretary of the Smithsonian Institution urging that the work be undertaken by the great scientific institution under his direction.

Secretary Walcott considered these appeals and under his direction a meeting of representatives of the National Museum, the Bureau of Fisheries, and the Biological Survey, the Bureau of Entomology, and the Bureau of Plant Industry of the Department of Agriculture was held. Their decisions confirmed the desirability of such a survey and in consequence of their opinions he prepared the following memorandum which was submitted to President Taft:

After consultation with various biologists, it appears without question that a properly conducted survey of Panama would yield important scientific results, both as regards additions to knowledge and to the collections of the National Museum. While the Isthmus is not so well endowed with large forms of life as the great continental areas, such as Africa, southern Asia, etc., its fauna and flora are rich and diversified. The collecting which has been carried on there has been on a rather limited scale, and an extensive and thorough survey would surely produce new scientific information of great value.

A part of the fresh-water streams of the Isthmus of Panama empty into the Atlantic Ocean and others into the Pacific Ocean. It is known that a certain number of animals and plants in the streams on the Atlantic side are different from those of the Pacific side, but as no exact biological survey has ever been undertaken, the extent and magnitude of these differences have yet to be learned. It is also of the utmost importance to determine exactly the geographical distribution of the various organisms inhabiting those waters, as the Isthmus is one of the routes by which animals and plants of South America have entered North America and *vice versa*. When the canal is completed, the organisms of the various watersheds will be offered a ready means of mingling together, the natural distinctions now existing will be obliterated, and the data for a true understanding of the fauna and flora placed forever out of reach.

By the construction of the Gatun Dam, a vast freshwater lake will be created, which will drive away or drown the majority of the animals and plants now inhabiting the locality, and quite possibly exterminate some species before they become known to science.

President Taft fully approved the plan for a biological survey and suggested that such arrangements be made with the secretary of war, the secretary of agriculture, and the secretary of commerce and labor as would enable him to have their active cooperation in this important work. The arrangements are now in an advanced state, and field parties will be sent to the isthmus at an early date.

The expenses of these parties will be borne from a fund contributed by a number of public spirited friends of the institution.

THE POPULATION OF THE UNITED STATES

The Census Bureau has issued a statement giving the results of the thirteenth census for the separate states. The figures and a comparison with the population of 1900 are as follows:

States	1910	1900	% Inc.
Continental U. S.	91,972,267	75,994,575	21.0
Alabama	2,138,093	1,828,697	16.9
Arizona	204,354	122,931	66.2
Arkansas	1,574,449	1,311,564	20.0
California	2,337,549	1,485,053	60.1
Colorado	799,024	539,700	48.0
Connecticut	1,114,756	908,420	22.7
Delaware	202,322	184,735	9.5
Dis. of Columbia	331,069	278,718	18.8
Florida	751,139	528,542	42.1
Georgia	2,609,121	2,216,331	17.7
Idaho	325,594	161,772	101.3
Illinois	5,638,591	4,821,550	16.9
Indiana	2,700,876	2,516,462	7.3
Iowa	2,224,771	2,231,853	—
Kansas	1,690,949	1,470,495	15.0
Kentucky	2,289,905	2,147,174	6.6
Louisiana	1,656,388	1,381,625	19.9
Maine	742,371	694,466	6.9
Maryland	1,295,346	1,188,044	9.0
Massachusetts	3,366,416	2,805,346	20.0
Michigan	2,810,173	2,420,982	16.1
Minnesota	2,075,708	1,751,394	18.5
Mississippi	1,797,114	1,551,270	15.8
Missouri	3,293,335	3,106,665	6.0
Montana	376,053	243,329	54.5
Nebraska	1,192,214	1,066,300	11.8
Nevada	81,875	42,335	93.4
New Hampshire	430,572	411,588	4.6
New Jersey	2,537,167	1,883,669	34.7
New Mexico	327,301	195,310	67.5
New York	9,113,279	7,268,894	25.4
North Carolina	2,206,287	1,893,810	16.5
North Dakota	577,056	319,146	80.8
Ohio	4,767,121	4,157,545	14.7
Oklahoma	1,657,155	790,391	109.7
Oregon	672,765	413,536	62.7
Pennsylvania	7,665,111	6,302,115	21.6
Rhode Island	542,610	428,556	26.6
South Carolina	1,515,400	1,340,316	13.1
South Dakota	583,888	401,570	45.4
Tennessee	2,184,789	2,020,616	8.1
Texas	3,896,542	3,048,710	27.8
Utah	373,351	270,749	34.9
Vermont	355,956	343,641	3.6
Virginia	2,061,612	1,854,184	11.2
Washington	1,141,990	513,103	120.4
West Virginia	1,221,119	958,800	27.4
Wisconsin	2,333,860	2,069,042	12.7
Wyoming	154,145	92,531	67.0
Alaska	64,356	63,592	1.5
Hawaii	191,909	154,001	24.6
Porto Rico	1,118,012	953,243	...
Military and naval	.....	91,219	...

THE PALEONTOLOGICAL SOCIETY

THE second annual meeting of the society will be held in the Carnegie Museum, Pittsburgh, Pa., beginning Wednesday morning, December 28, at 10 o'clock. President Charles Schuchert will preside over the meeting. The program will include a conference on the Criteria in Paleozoic Paleogeography, with the following subjects for discussion:

The Nature of Tertiary and Modern Marine Faunal Barriers and Currents, by William H. Dall.

The Value of Floral Evidence in Marine Strata as indicative of Nearness of Shores, by David White.

Are the Fossils of Dolomites indicative of Shallow, Highly Saline and Warm Seas? by Stuart Weller.

Were the Habitats of Reef-making Tabulata and Tetracoralla similar to those of Living Hexacoralla? by T. Wayland Vaughan.

The Stratigraphic Significance of the Wide Distribution of Graptolites, by Rudolph Ruedemann.

The Stratigraphic Significance of Bryozoa, by Edward O. Ulrich.

The Stratigraphic Significance of Brachiopoda, by Charles Schuchert.

The Stratigraphic Significance of Ostracoda, by R. S. Bassler.

The Relation of the Paleozoic Arthropods to the Strand Line, by John M. Clarke.

The Paleogeographic Significance of Land Vertebrates in Paleozoic Strata, by S. W. Williston.

MECHANICAL SCIENCE AND ENGINEERING IN THE AMERICAN ASSOCIATION

THERE have been promised the following papers for Thursday morning, December 29:

A. H. Blanchard: (*a*) "Comparison of English and American Traffic Regulations," (*b*) "Relations between Modern Traffic and the Alignment and Profile of Highway Design," (*c*) "The Present Status of the Use of Bituminous Materials in Road Construction in the U. S."

A. H. Blanchard and I. W. Patterson: "Methods of taking Traffic Census on Highways."

A. N. Johnson: "The Science of Highway Building."

E. F. Chandler: "The Amount of Stream Flow in the Northern Prairies."

F. W. McNair: "Consequence of the Solution of Air in a Hydraulic Air Compressor."

The program for Friday will be a symposium on aeronautics and related subjects. An appreciation of Dr. Chanute and his work by one or two members of the section will be given. The papers thus far promised are as follows:

J. Ansel Brooks: "A Study of Aviation in Europe during the Summer of 1910."

R. W. Wilson: "Determination of the Altitudes of Aeroplanes by Triangulation."

S. P. Ferguson: "An Indicator for Determining the Efficiency of Aeroplanes."

C. H. Peabody: "Technical Education in Aeronautics."

W. J. Humphreys: "Permanent Winds."

On Wednesday afternoon, the section will meet in joint session with Section B to hear the vice-presidential addresses of Professor J. F. Hayford and Professor L. A. Bauer. Other papers than those listed are partially promised and still others will be brought in between now and the dates of the meetings of the section.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Minneapolis, during convocation week, beginning on December 27, 1910.

American Association for the Advancement of Science.—Retiring president, Dr. David Starr Jordan, of Stanford University; president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Local Executive Committee.—Wilbur F. Decker, chairman; Frederic E. Clements, secretary; Leroy J. Boughner, Frederic B. Chute, James F. Corbett, James F. Ells, Wallace G. Nye, Henry F. Nachtrieb, Edward E. Nicholson, Francis C. Shenehon, Albert F. Woods, Frederick J. Wulling.

Section A—Mathematics and Astronomy—Vice-president, Professor E. H. Moore, University of Chicago; secretary, Professor G. A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.;

secretary, Professor A. D. Cole, Ohio State University, Columbus, O.

Section C—Chemistry.—Vice-president, Professor G. B. Frankforter, University of Minnesota; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering—Vice-president, Professor A. L. Rotch, Blue Hill Meteorological Observatory; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Dr. John M. Clarke, state geologist of New York, Albany, N. Y.; secretary, F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Jacob Reighard, University of Michigan; secretary, Maurice A. Bigelow, Columbia University, New York, N. Y.

Section G—Botany.—Vice-president, Professor R. A. Harper, University of Wisconsin; secretary, H. C. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor Roland B. Dixon, Harvard University; secretary, George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, the Hon. T. E. Burton, Cleveland, Ohio; secretary, Fred. C. Croxton, 1229 Girard Street, Washington, D. C.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor F. G. Novy, University of Michigan; secretary, George T. Kemp, Hotel Beardsley, Champaign, Ill.

Section L—Education.—Vice-president, President A. Ross Hill, University of Missouri; secretary, Charles Riborg Mann, University of Chicago, Chicago, Ill.

Permanent Secretary (for five years)—Dr. L. O. Howard, Washington, D. C.

General Secretary—Professor Frederic E. Clements, University of Minnesota.

Secretary of the Council—Professor John Zeleny, University of Minnesota.

American Mathematical Society (Chicago Section).—December 28–30.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28–29. President, Professor C. R. Mann, University of Chicago; secretary, Eugene R. Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 28–31. President, Professor Wilder D. Bancroft, Cornell University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The American Society of Zoologists (Central Branch).—December 29–30.

The Entomological Society of America.—December 27–28. President, Professor John B. Smith, Rutgers College; secretary, C. R. Crosby, 43 East Avenue, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor E. D. Sanderson, Morgantown, W. Va.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—December 28–31. President, Dr. Erwin F. Smith, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Secretary, Dr. Henry C. Cowles, University of Chicago, Chicago, Ill.

American Phytopathological Society.—December 28–30. President, Dr. F. L. Stevens, North Carolina College of Agriculture and Mechanic Arts; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Microscopical Society.—December 28, 29. Secretary, Dr. Thomas W. Galloway, James Millikin University, Decatur, Ill.

American Nature Study Society.—January 1. President, Professor Otis W. Caldwell, University of Chicago; secretary, Professor Fred L. Charles, University of Illinois, Urbana, Ill.

Sullivant Moss Society.—December 27–28. Acting secretary, Dr. George H. Conklin, 1204 Tower Avenue, Superior, Wis.

The American Psychological Association.—December 29–31. President, Professor J. H. Pillsbury, University of Michigan; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

ITHACA

The American Society of Naturalists.—December 29. President, Dr. D. T. MacDougal, Desert Botanical Laboratory, Tucson, Ariz.; secretary, Dr. Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists (Eastern Branch).—December 28–30. President, Professor Thomas H. Montgomery, Jr., University of Penn-

sylvania, secretary, Dr. Herbert Rand, Harvard University, Cambridge, Mass.

The Association of American Anatomists.—December 28–30. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Professor V. A. Moore, Cornell University; secretary, Charles E. Marshall, Michigan Agricultural College, East Lansing, Mich.

NEW HAVEN

The American Physiological Society.—December 27–29. President, Professor W. H. Howell, Johns Hopkins University; secretary, Professor A. J. Carlson, University of Chicago.

The American Society of Biological Chemists.—December 28–30. President, Thomas B. Osborne, Connecticut Agricultural College; secretary, Dr. Alfred M. Richards, University of Pennsylvania, Philadelphia, Pa.

PITTSBURGH

The Geological Society of America.—December 29, 31. President, Dr. Arnold Hague; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor Henry C. Cowles, University of Chicago; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Paleontological Society.—December 28–29. Secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

PROVIDENCE

The American Anthropological Association.—December 28–31. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 29. President, Dr. Henry M. Belden, University of Missouri; secretary, C. Peabody, Harvard University, Cambridge, Mass.

NEW YORK CITY

The American Mathematical Society.—December 28–29. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES OTIS WHITMAN, head of the department of zoology of the University of Chicago since 1892 and director of the Woods Hole Marine Biological Station for twenty years, died of pneumonia at his home at Chicago on December 6.

MR. R. A. SAMPSON, F.R.S., professor of mathematics and astronomy in the University of Durham, has been named astronomer royal for Scotland and professor of practical astronomy in the University of Edinburgh, in succession to Mr. F. W. Dyson, F.R.S.

SIR JOSEPH JOHN THOMSON, Cavendish professor of experimental physics at Cambridge, and Sir Victor Horsley, the London surgeon, have been elected corresponding members of the Prussian Royal Academy of Sciences.

LORD AVEBURY has been elected a corresponding member of the Paris Academy of Sciences in the section of anatomy and zoology.

WE learn from *Nature* that Emperor Francis Joseph has conferred the Austrian great gold medal of science and literature upon Mr. E. Torday, the leader of the scientific expedition sent out by the British Museum to study the native tribes in the Kasai basin of the Congo.

THE city of Philadelphia, on the recommendation of the Franklin Institute, has awarded the John Scott legacy premium and medal to Dr. L. H. Baekeland, of Yonkers, New York, for his invention of bakelite. The Franklin Institute has awarded Elliott Cresson medals for "distinguished, leading and directive work," in their respective fields of endeavor to the following: Dr. Harvey W. Wiley, chief chemist to the Department of Agriculture, Washington, for his work in the fields of agricultural and physiological chemistry. John Fritz, Bethlehem, Pa., for his work in the development of the iron and steel industries. John A. Brashear, Pittsburgh, Pa., for his work in the production and perfection of instruments for astronomical research. Edward Weston, Newark, N. J., for his work in electrical discovery and in the advancement of electrical application. Ernest Rutherford, professor of physics, Owens College, Victoria University, Manchester, Eng.,

for his work in the advancement of the knowledge of electrical theory. Sir Joseph John Thomson Cavendish, professor of experimentai physics, Cambridge University, for his work in the advancement of knowledge of the physical sciences. Sir Robert A. Hadfield, Sheffield, England, for his work in the advancement of knowledge of metallurgical science.

Mr. N. H. Darton, for many years geologist of the U. S. Geological Survey, has been appointed the geologist of the new U. S. Bureau of Mines with headquarters at Washington, D. C. He will continue his investigations of the geological conditions under which explosive gases occur in coal deposits.

Dr. Allerton S. Cushman has retired from the position of assistant director and chemist in charge of the division of tests, office of public roads, to undertake industrial research work in Washington.

Owing to ill-health Mr. Goodfellow, the leader of the British expedition to Dutch New Guinea, has been compelled to return home. The Committee of the British Ornithologists' Union have appointed in his place Captain C. G. Rawling, who represents the Royal Geographical Society on the expedition.

Dr. Daniel T. MacDougal gave an illustrated address on "Desert Problems" before the Sigma Xi Society of Purdue University on the evening of December 3, 1910.

Professor Robert DeC. Ward, of Harvard University, gave a lecture before the departments of geology and biology of Colgate University, on the evening of December 8, on "The Coffee Country of Brazil, with Special Reference to Climate."

"A Soils Survey for Minnesota" was the topic of an address by Professor A. R. Whitson, of the soils department of the Wisconsin College of Agriculture before the Northern Minnesota Development Association which met at Brainard, Minnesota, December 2.

We regret to record the death of Dr. Octave Chanute, known for his important contributions to scientific aviation. Dr. Chanute was born in Paris in 1832.

Professor Cooper D. Schmidt, professor of mathematics for twenty-one years in the University of Tennessee and dean of the university, has died at his home in Knoxville, Tenn., aged fifty-one years.

The Chemists' Building Company, organized to promote the interests of chemical science and industry in America, has erected a ten-story fireproof building, on a lot 56 feet wide and 100 feet deep, at 50–54 East 41st Street, New York City. The lower half of this building is leased to the Chemists' Club, and contains all the appurtenances of a social club, together with a large auditorium for scientific meetings and ample space for a complete chemical library and museum. The five upper stories have been specially constructed for laboratory purposes, and can be rented either as entire floors, or in suitable subdivisions, to analytical, commercial or research chemists, physicists, bacteriologists, etc.; but not as manufacturing laboratories. They are provided with ventilating flues, water, gas and electric mains, steam, refrigerating and compressed-air lines, in suitable locations. The building will be ready for occupancy in the beginning of March, when the rooms will be inaugurated by appropriate ceremonies.

A club that has for its purpose the study of breeding problems in relation to animals and plants, has been formed at the University of Wisconsin by the members of the faculty of several departments and graduate students working along biological lines. The officers are: Dr. Leon J. Cole, associate professor of experimental breeding, president; Mr. Augustus J. Rogers, instructor in horticulture, secretary. The membership includes instructors and graduate students from the colleges of letters and science and agriculture and the school of medicine.

A decree has been published by the Italian government creating a commission to examine the new theory put forward as to the cause of pellagra and to formulate any changes in the existing law of protection that may be considered desirable. The commission consists of nine members, all doctors with the exception

of Prince Teano, deputy, who was chiefly instrumental in calling the attention of the Italian government to the discovery of the English commission on pellagra.

THE annual meeting of the College Entrance Examination Board was held at Columbia University on November 12. Tufts was admitted to membership, bringing up to thirty the total number of colleges represented. A standing committee of seven was named to study the reading and rating of examination books and the standards of marking. The list of examiners appointed to prepare examination questions in the sciences for 1911 is as follows:

Botany—Chief examiner, Willard Winfield Rowlee, Cornell; associates, Mary Elizabeth Kennedy, Mount Holyoke; Louis Murbach, Central High School, Detroit, Mich.

Chemistry—Chief examiner, Alexander Smith, University of Chicago; associates, Gregory Paul Baxter, Harvard; Boynton Wells McFarland, New Haven High School, New Haven, Conn.

Mathematics—Chief examiner, Robert Woodworth Prentiss, Rutgers; associates, Herbert Edwin Hawkes, Columbia; Edward B. Parsons, Boys' High School, Brooklyn.

Physics—Chief examiner, Frank Allan Waterman, Smith; associates, William Edward McElfresh, Williams; Daniel Edward Owen, William Penn Charter School, Philadelphia, Pa.

Zoology—Chief examiner, George Howard Parker, Harvard University; associates, Charles Wright Dodge, University of Rochester; Walter Hollis Eddy, High School of Commerce, New York.

THE London *Times* states that by the generosity of Sir Julius Wernher, who recently placed a sum of £10,000 at the disposal of the committee for the purpose, a much-needed extension of the department of metallurgy has now been begun. The department has, up to the present, been accommodated in a number of scattered rooms in Bushy House, which, in consequence of the increase and importance of the work, have become quite inadequate. Plans have been prepared in consultation with Dr. Rosenhain, the superintendent of the department, and the contract has been let to Messrs. Dick, Kerr and Co., who have already made good progress with the foundations.

THE Sedgwick Memorial Museum, of Cambridge, has received a valuable gift of fossils, etc., from the widow of the Rev. George Ferris Whidborne, who had previously presented to this museum his collection of Devonian fossils. Mrs. Whidborne has now given the remainder of his collection, with all his scientific books and manuscripts, together with a series of photographs and other illustrations.

THE University of Pittsburgh announces the establishment of four industrial fellowships: No. 1, in the chemistry of baking, yielding $750 a year for two years, with a cash prize of $2,000. Nos. 2, 3 and 4, for an investigation with a view to eliminating or abating the smoke nuisance in large cities, yielding $2,000, $1,500 and $750 per year, respectively, for two years, together with a large additional consideration.

THE U. S. Geological Survey has published as Bulletin 444 a bibliography of North American geology for the year 1909, by J. M. Nickles. This volume covers all publications on the geology of North America that were printed anywhere in the world in 1909, showing the authors, titles and, briefly, the scope or contents of more than thirteen hundred books and papers. The bulletin includes a comprehensive index.

THE proceedings of the third International Congress for Home Education comprises 8 volumes in which specialists in pedagogy discuss the study of childhood, and education of children before, during and after their school years, the education of abnormal children and the various subjects relating to childhood. The exchange of opinions which was evoked at this congress by the papers presented will be published in a separate volume, the ninth in the series, which will appear shortly. The 9 volumes will be sent to all those who will be registered with the secretary general of the congress, L. Pien, 44 Rue Rubens, Brussels, Belgium, before the first of January. Such persons will be considered members of the congress and will receive the 9 volumes upon payment of the dues, 10 francs ($2). After

that date these publications will be found only in the hands of booksellers at a price considerably higher. These volumes contain more than 300 articles. A certain number of papers —in the neighborhood of 100—were not received by the bureau in time for publication. The members of the congress will find these reviewed in the *Revue de l'Education familiale,* of which sample copies may be obtained free of charge by applying to the secretary general, as mentioned above. Probably the fourth International Congress for Home Education will be held in the United States. A commission has been appointed to take the matter under consideration. Professor Monroe, of the State Normal School, Montclair, N. J., is secretary of this commission.

At the first Optical Convention, held in 1905, a permanent committee was appointed, to which was entrusted the task of deciding upon a suitable date for the holding of a second convention, and of taking the necessary steps to initiate it. According to *Nature* a general meeting of the committee and of members of the optical industry, representatives of optical bodies and societies, and others interested in optical questions, was held on November 29, to consider and discuss proposals for the organization of a second convention. The chair was to be taken by Dr. R. T. Glazebrook, C.B., F.R.S., director of the National Physical Laboratory, as chairman of the permanent committee, and all interested were invited to be present at the meeting. The main features of the scheme which the members of the existing executive committee had in view were in broad outlines as follows: (1) an exhibition of optical and allied instruments; (2) the preparation of a catalogue of optical and allied instruments of British manufacture to serve as a convenient work of reference for all users of optical and scientific instruments, not necessarily to be limited to instruments actually exhibited; (3) the holding of meetings for the reading of papers and for discussions and demonstrations on optical subjects; (4) the publication of a volume of proceedings, in which these papers will be collected together.

The *Geographical Journal* reports that with a commission from the Turkish authorities, Dr. Alois Musil has this year carried out further explorations in northern Arabia, this time in the region adjoining the Hejaz railway. Leaving Vienna in April, accompanied by Dr. Leopold Kober (geologist) and his former coadjutor, Rudolf Thomasberger (cartographer), he proceeded by way of Beirut and Damascus to Maan, where he organized his caravan, consisting of three servants and seven riding-camels. During the next two months he made a thorough examination of the imperfectly known area extending from Maan southwards to Al Gaw, and from the Red Sea eastward to Teima and the Wadi Sirhan, and including the Biblical land of Edom. The railway was used as the base for supplies, but the journey was not without danger, especially in the country of the fanatical tribes towards the south, whose suspicions were aroused by the light color of the beards of the traveler's companions, doubt being thus thrown on their character of Muslims. The scattered nature of the posts maintained by the Turks renders them powerless against the Beduin. There had been no rain for four years, and the temperature on one occasion rose to 55° C. (131° Fahr.), but the traveler was able to secure a large amount of ethnographical and linguistic material—lists of names, drawings, copies of inscriptions, and so forth. One result of the journey is, Dr. Musil believes, the identification for the first time of the true Biblical Sinai. His companions carried on work in other departments. Plants and insects were collected and geological investigations made, the country being found to consist of granite, sandstone and basalt, succeeding each other from west to east. The mapping was effected by plane-table and compass, the use of the theodolite being found impossible. Notes on the form and nature of the surface, or at least a record of the changes in direction of the route, were made whenever it was possible to elude the vigilance of the Beduin, who accompanied the party from curiosity. At the night encampments the latitude was taken by alti-

tude of the pole star, and altogether nearly 200 altitudes by aneroid were determined, the meteorological station at Beirut supplying a record of the daily march of the barometer for purposes of comparison, while the leveled line of railway gave a reference to sea-level. The map, like Dr. Musil's previous one of Arabia Petræa, has been plotted on the scale of 1:300,000, but it will be published on a smaller scale. The results of the journey will be issued by the Vienna Academy of Sciences.

UNIVERSITY AND EDUCATIONAL NEWS

COLUMBIA UNIVERSITY has received $100,000 to be ultimately used for promoting cultural relations between Germany and the United States, and $30,000 from Mr. E. D. Adams, to buy and equip a Deutsches Haus for the university. In addition to several other gifts, a farm of 320 acres, valued at $15,000 has been given for an experiment station in connection with projected instruction in agricultural engineering.

ANNOUNCEMENT is made of a gift of $100,000 to the Johns Hopkins University endowment fund by Mr. R. Brent Keyser, chairman of the board of trustees. The university must raise $750,000 in order to secure $250,000 from the general educational board.

THE University of Pittsburgh has received from Mr. Joseph C. Trees, '93, a gift of $100,000, to be applied toward the construction of a new gymnasium and athletic field.

MR. FREDERICK WEYERHAUSER, of St. Paul, has promised to erect a $150,000 auditorium and conservatory building for Augustana College at Rock Island, Ill.

THE dedication of the new Science Hall at Howard University, Washington, took place on December 13. The principal addresses were given by Dr. Henry S. Pritchett, president of the Carnegie Foundation, Dr. William H. Welch, of Johns Hopkins University, and Dr. Booker T. Washington, principal of Tuskegee Institute.

PROFESSOR FREDERIC S. LEE has been appointed to the directorship of the department of physiology of Columbia University. It is expected that the staff of the department will be increased beyond its present membership by the appointment of several additional trained physiologists.

DR. EDWARD MARTIN, professor of clinical surgery at the University of Pennsylvania, has been elected to the John Rhea Barton professorship of surgery to succeed Dr. J. William White.

DR. F. LYMAN WELLS, formerly assistant in pathological psychology in the McLean Hospital, has entered upon the duties of assistant in experimental pathology in the Psychiatric Institute of the New York State Hospitals, and lecturer in psychology in Columbia University.

AMONG recent appointments in botany at the Michigan Agricultural College are the following: Dr. Wm. H. Brown, Ph.D. (Hopkins), to be research assistant in plant physiology under the Adams fund, at the Agricultural Experiment Station, for three fourths of his time, the remainder to be devoted to teaching advanced plant physiology in the botany department of the college. Dr. Brown comes from the Desert Laboratory, Tucson, Arizona, where he has been spending some months in research. Professor G. H. Coons to be research assistant in plant pathology at the Experiment Station, devoting one fourth of his time to teaching plant pathology at the college. Professor Coons is now assistant professor of agricultural botany at the University of Nebraska. He will assume his duties at the Michigan Agricultural College on January first.

M. MAURICE LERICHE, of Lille, has been appointed professor of geology at the University of Brussels.

DISCUSSION AND CORRESPONDENCE

IS THIS A DYNAMICAL PROOF OF THE PYTHAGOREAN THEOREM?

As indicated in the figure, $O-p$ is assumed to be a rod without mass which can revolve in the plane of the paper about O as center. $1-2$ is also assumed to be another rod without mass which lies in the plane of

the paper with its center located at p. Concentrated at each end of the rod $1-2$ are equal masses m, m, each distant r from p. Let R equal the distance $O-p$, x the distance $O-1$, and y the distance $O-2$.

When the system revolves about O as center, the point p will have a linear velocity;

$$v = ds/dt = R\,da/dt = RW,$$

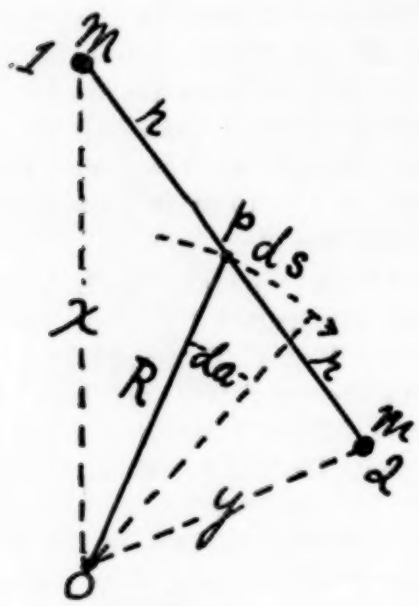

Fig. 1

where ds is the element of arc described in time, dt, da is the differential angle through which $O-p$ turns and W is the angular velocity of $O-p$.

1. Assume that the rod $1-2$ is free to turn on p as center. Since m at 1 and m at 2 are equal and equally distant from p, p is the center of mass. No motion, force or acceleration which exists at the point p can produce rotation of $1-2$ about p as center. This must be so, as it is axiomatic in dynamics that, when there is a force or acceleration at the center of mass only of a body, there remains no couple to produce rotation of the mass, and by Newton's first law, a force must act before a mass can change its state of rest or motion.

In the condition, where $1-2$ is free to turn about p, the kinetic energy then of the system must be,

$$E' = \tfrac{1}{2}(2m)v^2 = mR^2W^2. \qquad (1)$$

2. Conceive the rod, $1-2$, to become rigidly attached at p. Then, as $O-p$ revolves about O with angular velocity W, $1-2$ also revolves about p with like angular velocity. By making the attachment at p rigid the system is forced to take on an additional kinetic energy which can be only that, which is a result of the additional motion now possessed by m at 1, and by m at 2, in virtue of their rotation about p as center. This added kinetic energy is:

$$E'' = \tfrac{1}{2}(2m)r^2W^2 = mr^2W^2. \qquad (2)$$

Hence, the total kinetic energy of the system when $1-2$ is rigidly attached at p, is:

$$E = E' + E'' = mW^2(R^2 + r^2). \qquad (3)$$

3. With the attachment still rigid at p, the kinetic energy of m at 1 is, plainly, that which is due to its rotation, at distance x, about O as center, and this is

$$E_0' = \tfrac{1}{2}mx^2W^2. \qquad (4)$$

Likewise, the kinetic energy of m at 2 about O as center is

$$E_0'' = \tfrac{1}{2}my^2W^2. \qquad (5)$$

The total kinetic energy must be the sum of these two, or

$$E = E_0' + E_0'' = \tfrac{1}{2}mW^2(x^2 + y^2). \qquad (6)$$

Expressions (3) and (6) are both true expressions for the same kinetic energy and hence they may be equated, giving as result,

$$\tfrac{1}{2}(x^2 + y^2) = R^2 + r^2. \qquad (7)$$

In (7) we have a geometrical relation of some interest, but in the particular case when $y = x$, that is, when line $1-2$ is perpendicular to line $O-p$, we have the result,

$$x^2 = R^2 + r^2. \qquad (8)$$

Thus it is proved by dynamical considerations only that in a right-angled triangle the square on the hypothenuse is equal to the sum of the squares on the other two sides.

Edwin F. Northrup
Palmer Physical Laboratory,
Princeton, N. J.,
October 7, 1910

WOMEN AND SCIENTIFIC RESEARCH

There are now nearly as many women as men who receive a college degree; they have on the

average more leisure; there are four times as many women as men engaged in teaching. There does not appear to be any social prejudice against women engaging in scientific work, and it is difficult to avoid the conclusion that there is an innate sexual disqualification. . . . But it is possible that the lack of encouragement and sympathy is greater than appears on the surface, and that in the future women may be able to do their share for the advancement of science.[1]

The article affording this quotation commands attention on account of both the method used and the results reached. In a field where impression, conjecture and personal bias play a large, if not a determining rôle, one must welcome such a well-considered plan for employing a statistical and hence impersonal method. Figures have no feelings. Perhaps none of the results set forth are more striking than the statement that in 1910 only eighteen women are to be found in the first thousand scientific persons. A search for the causes of this fact is in itself a sociological task meriting some expenditure of scientific effort. Would the author of the article referred to be willing to call his "conclusion" a hypothetical explanation, and to admit one or two competing hypotheses?

As matters stand at present in America a young woman can not fairly complain that she is denied opportunity to study science. If one institution refuses admission to her, another equally good opens wide its doors; if some eminent professor denies her a place in his laboratory, another, equally eminent, will welcome her. But is such opportunity all that is involved? Did the young woman have a fair chance as a little girl? It would appear, on the face of it, that girls and boys in these days and this country enjoy equal opportunities. They may read the same books and play the same games; they pass through the same grade schools and, in most towns, the same high school; finally, they receive, as a rule, the same preparation for college. But is even this all that is involved?

Whoever will watch groups of girls and boys in any grade school must realize that out of sight, in the homes, distinctions are introduced which result ultimately in mental handicap for the girl. This discrimination manifests itself primarily in compelling her attention in matters of dress. Observe the hat constructed for the little girl's wearing and contrast it with the cap worn by a boy of her own age. Good brains go to waste under a hat like that because it must receive the attention that the boy may save to bestow on a hundred things worth while. The rest of the girl's apparel corresponds of course to her hat. What is the prevailing style, how shall her clothes be made and trimmed, and does she look pretty in them, are considerations that grow with the girl's growth. If she is destined to be a member or, let us say, an associate member of the leisure class she can not proceed far in her teens before her social environment compels acceptance of the notion that a girl must be, first of all, attractive and pleasing—if possible, a social ornament. A girl is free to elect science in the high school, but what does the freedom avail if science appears undesirable on the ground that it in no way contributes to her accomplishments. Further than this, a girl loses as a rule the informal preparation for science that a boy secures. The proprieties and dainty clothing cost her many a lesson that her brother learns; and who concern themselves to take a girl to the blacksmith shop, the power-house, and the stone-quarry, to the places where the steam-shovel and the pile-driver are at work. Yet it was a little girl who once asked, "Why do the cars lean in when they go around a curve?" a little girl also who concluded her explanation of a home-made filter by saying, "And so, you rinse the water with gravel." Given the same circumstances, including the circumstance of encouragement, and it is hardly to be doubted that the rational curiosity to know the causes of things would be found in girls as it is in boys. Opportunity is rendered ineffective and the world of natural phenomena inviting to observation and analysis is denied to girls because they are assigned to an artificial environment demanding an emotional re-

[1] "Further Statistical Study of American Men of Science," SCIENCE, November 11, 1910.

sponse; and then we wonder at it when young women in their junior and senior years in college elect music and literature in preference to mechanics and physiology; we wonder and we frame theories about feminine predilections.

Is there any other cause, operating perhaps with the one just described, that may account for the less than two per cent. Table X. in the statistical study gives the number of scientific men connected with institutions when there are three or more. Fifty-eight institutions appear in the list with a total of 762 men. Let us drop from this list the four colleges for women. They will scarcely be missed since they take only nineteen of the 762. Of this list of fifty-four institutions just which ones open their major positions freely and fairly to persons of gifts and attainments without regard to sex? By a major position is meant one that a man of the select first thousand would be willing to occupy. Women are quite welcome to become experts in washing bottles and adding logarithms and dusting specimens. Even in the case of high school science the best positions in physics and chemistry are reserved for men. A young woman, however strongly inclined to devote herself to science, may well hesitate to proceed to a science doctorate when she considers that Table X. There is indeed room for doubt whether we should have any thousand men of science if all gifted and ambitious young men were confronted by such barriers as a young woman is obliged to face to-day. We should find these young men going into literature, law, politics, business; but scarcely into science. It appears therefore difficult to avoid the conclusion that other factors besides innate sexual disqualification must be reckoned with in attempting to account for the insignificance of women's share in the advancement of science.

ELLEN HAYES

EMINENCE OF WOMEN IN SCIENCE

TO THE EDITOR OF SCIENCE: In Dr. Cattell's "Statistical Study of American Men of Science"[1] occurs the following comment on the fact that there are "only 18 women among 982 men:" "There are now nearly as many women as men who receive a college degree; they have on the average more leisure; there are four times as many women as men engaged in teaching." In view of a preceding statement (p. 675) that "the advancement of science depends mainly on those who hold chairs in our colleges and universities," I would suggest that, before drawing "the conclusion that there is an innate sexual disqualification," there should be added to the premises from which any conclusion is drawn the well-known fact that, except in some of the women's colleges where the opportunities for research are limited and the salaries notably low, women are not considered eligible for chairs in the sciences named. If they have any positions in the departments at all, it is chiefly as laboratory assistants.

Another conclusion which might be drawn is that women in larger proportions than men (p. 675) are in the class of "amateurs" or scientific persons who, not needing to earn their living, devote their lives to scientific research.

It is indeed "possible," as the author says, that "the lack of encouragement and sympathy is greater than appears on the surface." Until women are more generally given an equal chance with men in academic recognition and remuneration, it is futile to attempt to determine, in terms of statistical tables or even of scientific reputation or eminence, how much "they are able to do for the advancement of science."

MARION TALBOT
THE UNIVERSITY OF CHICAGO,
November 14, 1910

THE CENTURY DICTIONARY SUPPLEMENT

IN the supplement to the Century Dictionary which has recently been issued, my name appears as the responsible editorial contributor for terms in plant physiology. This is an error which, I am informed by the editor of the Century Dictionary, will be corrected in subsequent copies of the supplement. I did revise the terms in plant physiology for the

[1] SCIENCE, November 11, 1910, p. 676.

new edition of the old dictionary, but did not write those in the supplement.

R. E. B. McKENNEY
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

SCIENTIFIC BOOKS

Dioptrographic Tracings in Four Normæ of Fifty-two Tasmanian Crania. Transactions of the Royal Society, Victoria. Vol. V. (Part I.) 1909. By RICHARD J. A. BERRY and A. W. D. ROBERTSON. Pp. 1–11 notes, 211 plates.

The volume at hand is an exceptional publication, but perhaps justified under the circumstances. It consists of a large series of plates with well executed dioptrographic drawings of 52 Tasmanian crania, without measurements and with none or but the scantiest descriptive notes. Forty-one of these crania are new to science, having been discovered in private collections or excavated by the authors. As the total number of Tasmanian crania known before amounted to only 79, the new material can well be regarded as a precious addition. But the very value of it augments the wish for a thorough report. The plates will be useful and both the authors, as well as the Royal Society of Victoria, have earned the thanks of anthropologists for their publication, but they are by no means sufficient. Measurements on drawings or photographs, even though these be of "natural size," can never be taken with accuracy and be used with the confidence of those secured by accurate instruments and according to the standard methods on the specimen itself. Besides that, numerous measurements of importance, such as the surface arcs and the circumference, can not be even approximated on illustrations.

But it is specially the lack of descriptive notes which will be felt. The illustrations of Skull No. 9 may be cited as an example. In 9B, frontal view, and 9D, back view, there is visible a depression over the upper portion of the parietals. Such a feature may be due to the pronounced elevation of the sagittal region, but it may also be due to senile changes. In the absence of description one is left in uncertainty. The sutures on the specimen are represented as if free from obliteration, but they are thus shown on practically every skull in the series, and yet some of the jaws indicate an age where more or less obliteration could be expected. The illustrations of the teeth, as general in drawings of this nature, are entirely unsuitable for study. The position of the dacryons does not seem in all the cases to be accurate—for instance in plates 12B, 15B, 21B and 23B. In a number of the cases, such as 36C, one would like to know more than the pictures show as to the characteristics of the supraorbital ridges or arch. The inion point is difficult to determine with accuracy, it differs in position, and it does not generally represent the posterior terminus of the maximum glabello-occipital diameter, hence the prominent part given to it is scarcely deserved; etc.

It is to be hoped that the authors will furnish in time a good descriptive account of the valuable specimens in their hands and in their reach.

ALEŠ HRDLIČKA

The Plant Life of Maryland. By FORREST SHREVE, M. A. CHRYSLER, FREDERICK H. BLODGETT and F. M. BESLEY. Maryland Weather Service, Volume III. Pp. 533, pls. 39. Baltimore, 1910.

This report on the plant life of Maryland is a valuable contribution to plant geography and ecology. The introduction by Shreve describes the general geography of the state together with a discussion of its climate and physiography, while he gives a statement of the purposes of the work from the botanic standpoint. Dr. Shreve in Part II. gives in detail the general results of the survey of the state, as to its floristic plant geography, while in Part III., the ecologic plant geography is discussed from the regional aspect. The vegetation of the coastal zone, eastern shore district, is given by Shreve, that of the western shore district by Chrysler, while Blodgett has written the section on the upper midland district of the state, followed by a description of the mountain zone by Dr. Shreve. Not the least valuable

part of this volume, which ought to find its way into the hands of all working ecologists, are the chapters devoted to the relation of natural vegetation to crop possibilities, the agricultural features of Maryland and the forests and their products. All through the volume the several authors discuss the influence of climate and soil conditions on the distribution of the native plants. This study is made all the more valuable, because it is based on a careful geologic survey made by the state survey, and on the splendid soil maps and detailed soil study of several portions of the state by the agents of the U. S. Bureau of Soils. The illustrations, carefully chosen out of a large number taken to show the vegetation of the state, depict some of the more striking plant formations.

A list of the 1,400 species of plants collected during the botanic survey gives in a detailed manner the floral richness of the state.

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SPECIAL ARTICLES

ON A MODIFIED MENDELIAN RATIO AMONG YELLOW MICE.[1]

This paper is based on a series of experiments made possible through a grant from the Carnegie Institution of Washington, for which grateful acknowledgment is hereby made.

In 1905 Cuénot called the attention of those interested in the experimental study of heredity to the fact that in his experiments he was unable to obtain any homozygous yellow mice. Heterozygous yellows he obtained in abundance, and found that in such animals yellow was dominant to all other color forms, including the gray color of wild house mice. This fact in itself is worthy of note, for among the rodents already experimented on, mice are the only animals in which the yellow coat dominates black or brown.

Cuénot found that in a total of 363 young obtained in yellow × yellow crosses, 263, or 72.45 per cent., were yellow, and 100, or 27.55 per cent., were of other colors. In view of the fact that the percentage of yellows that he obtained was smaller than the Mendelian expectation by 2.55 per cent., he tested individually the breeding capacity of the yellow animals that he had obtained. In no case was he able to discover an animal which in crosses with gray or black animals would give only yellow young. But if any of the yellows had been homozygous such a result would of course have been obtained, and from the application of the ordinary Mendelian principles we should expect one third of the yellows that he tested to have been of this sort.

It is then perfectly certain that in his experiments homozygous yellows were not formed. With this in mind, he sought an explanation of the percentage of yellows that he had obtained. If the homozygous yellow class had simply been wanting entirely, he should have obtained 66.66 per cent. of yellow mice, and the remaining 33.33 per cent. of other colors. Cuénot explained the observed increase above 66.66 per cent. by supposing that all of the "yellow" eggs which would naturally, as a result of random unions of gametes, be fertilized by yellow sperm, fail to be so fertilized, but that some of them subsequently are fertilized by non-yellow sperm and so produce heterozygous yellow young. The proportion of yellow young produced is, accordingly, greater than two thirds but less than three fourths.

Bateson and Punnett commenting on Cuénot's results, point out the fact that even if two gametes bearing the character "yellow" are unable to unite with each other, there should, nevertheless, be no deficiency of yellow young, that is, they should equal 75 per cent. For suppose a *yellow* egg is first approached by a *yellow* sperm. If no union of the two occurs, the egg may still remain capable of producing a yellow zygote, provided it presently meets a *non-yellow* sperm. But this should in all cases be possible, since spermatozoa are regularly present in excess, and the spermatozoa of a yellow mouse are by hypothesis half yellow and half non-yellow in character.

[1] Contributions from the Laboratory of Genetics of the Bussey Institution, No. 6.

Now the evidence which will presently be offered shows that, contrary to the idea of Cuénot as well as to the suggestion of Bateson and Punnett, the yellow egg which by chance has met a yellow sperm has its career ended thereby. It is not thereafter capable of fertilization by a non-yellow spermatozoon. So it seems probable that the homozygous yellow zygote actually is formed and then perishes, just as in the observations of Baur on an *"aurea"* race of *Antirrhinum*, the homozygous yellow seedling not only forms, but may germinate, yet for lack of assimilating power develops no further, so that all the surviving *"aureas"* are heterozygous and these are to the recessive green plants as 2:1.

In November, 1907, the writers started with a small number of yellow mice in an attempt to obtain a homozygous yellow animal. This quest was not successful, but as the numbers of animals increased and the scope of the experiment became greater, some results were obtained of a striking nature and different enough from previous results to make an extensive study of the subject advisable. Such a study has been carried on during the last two years, and up to date the young in yellow × yellow crosses have totalled 1,235.

Of these young, as will be seen in the following table, 800 have been yellow and 435 non-yellow. This means that instead of the 75 per cent. heterozygous yellows called for by Bateson and Punnett's hypothesis, or the 72.45 per cent. obtained by Cuénot in 365 young, there have been obtained 64.77 per cent. yellow, a deviation of only 1.23 per cent. from the 66.66 per cent. that we should expect if the homozygous yellow class is entirely absent.

The result observed by us, 64.77 per cent. yellow in 1,235 young, is a wide deviation from 75 per cent., but close enough to 66.66 per cent. to enable us to say with considerable certainty that the homozygous yellow class is entirely lacking and is not replaced by heterozygous animals of the same color.

A still more striking result is obtained by adding to the total of young obtained in the experiment above mentioned the 363 young of Cuénot's experiments. We then have 66.52 per cent. yellow young in a total of 1,598, a deviation of only 0.14 per cent. from the expected 66.66 per cent.

A table showing the progress of the experiment follows, to which is appended in similar form a statement of Cuénot's results:

Ledger No.	Yellow Young	Non-yellow Young	Total Young	Per Cent. Yellow
1–5,400	423	238	661	63.99
5,401–5,514	22	11	33	66.66
5,515–5,824	97	45	142	68.30
5,825–6,437	184	110	294	62.58
6,438–6,621	74	31	105	70.47
Total	800	435	1,235	64.77
Cuénot's results.....	*263*	*100*	*363*	*72.45*
Grand total.	1,063	535	1,598	66.52

To state in another way the closeness of agreement between the expected and the observed percentages of yellow young, we may say that the ratio of 800 yellow to 435 non-yellow obtained in our experiments equals 1.943 yellow to 1.057 non-yellow, the deviation from the 2:1 ratio being 0.057. Now the theoretical "average error" in the case of a Mendelian 2:1 ratio based on the given number of observations (1,235) as calculated by Johannsen's formula (1909, p. 403) is ± 0.013, which is slightly less than the observed error. If, however, Cuénot's totals are added to ours, the deviation from the 2:1 ratio is reduced to 0.005, while the theoretical "average error" (for 1,598 observations) is ± 0.011. The observed deviation is therefore well within the limit of error and so points strongly to the 2:1 ratio as the true ratio.

Cuénot (1908) found that when yellow mice are mated *inter se*, smaller litters of young are obtained than when yellow mice are mated with non-yellow ones. This observation we can confirm from a study of larger numbers than were reported in Cuénot's experiments. The averages reported by Cuénot in the respective cases, based on a careful count of 50 litters of either sort, are 3.38 and 3.74, respectively. From yellow × yellow matings we have obtained 277 litters including 1,305 young, an average of 4.71 young to a

litter. From yellow × non-yellow matings, 325 litters have been obtained, including 1,812 young, an average of 5.57 young to a litter. These averages are considerably higher than Cuénot's, indicating either a healthier stock of animals or better experimental conditions. Qualitatively, however, the results obtained in the two cases are completely in accord. The yellow × non-yellow matings produced larger litters than the yellow × yellow matings, but not so much larger as we should expect if homozygous yellow zygotes simply perished without otherwise affecting the character of the litter. For, in that case, the two categories of litters should be to each other in average size as 3:4, but we find that they were really as 3.38:4. The litters of yellow × yellow parents, instead of being 25 per cent. smaller, are only 15.5 per cent. smaller than those of yellow × non-yellow parents. In other words, when 100 pure yellow zygotes perish, they cause 38 other zygotes to develop in their stead. How can this be brought about? Cuénot supposes that some of the potential pure yellow combinations really become heterozygous yellow combinations and so swell the size of the litter. But in that case the total percentage of yellows should exceed 66.66 per cent., which it does not in our experience. We are forced, therefore, to conclude that the perishing of a pure yellow zygote makes possible the development of a certain number of *other* fertilized eggs.

Two ways may be suggested in which this might come about. First, more eggs may normally be liberated at an ovulation than there are young born subsequently. In that case, failure of some eggs to become attached to the uterus may make the chances greater that the remainder will become attached, or the perishing of some may make the chances greater that the rest will successfully complete their development. Or secondly, the production of a relatively small number of young at one birth may lead indirectly to more free ovulation subsequently, and so to the production of a larger litter at a second birth. It should be possible to test the validity of both these hypotheses experimentally.

The result here described for yellow mice, in common with that of Baur in the case of *Antirrhinum,* would seem to show that a Mendelian class may be formed and afterwards be lost by failure to develop. In other words, a physiological inability to develop may permanently modify a Mendelian ratio, causing the loss of an entire class.

As regards the matter of selective fertilization of the egg discussed by Wilson and Morgan in connection with this case, it is evident that nothing of the sort here occurs.

PAPERS CITED

Bateson, W., 1909. "Mendel's Principles of Heredity." See p. 119.

Baur, E., 1907. "Untersuchungen über die Erblichkeitsverhältnisse einer nur in Bastardform lebensfähigen Sippe von Antirrhinum majus." *Ber. d. Deutsch Bot. Gesellschaft,* 25, p. 442.

Cuénot, L., 1905. "Les races pures et leurs combinaisons chez les souris." *Arch. Zool. Exp.* (4), III., Notes et Revue, p. cxxiii.

—— 1908. "Sur quelques anomalies apparentes des proportions Mendeliénnes." Ib., IX. Notes et Revue, p. vii.

Johannsen, W., 1909. "Elemente der exakten Erblichkeitslehre." Jena.

Morgan, T. H., 1905. "The Assumed Purity of the Germ-cells in Mendelian Results." Science, 22, p. 877.

Wilson, E. B., 1906. "Mendelian Inheritance and the Purity of the Gametes." Science, 23, p. 112.

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FURTHER DATA REGARDING THE SEX-LIMITED INHERITANCE OF THE BARRED COLOR PATTERN IN POULTRY[1]

In two previous papers[2] the writers have de-

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 22.

[2] Pearl, R., and Surface, F. M., "On the Inheritance of the Barred Color Pattern in Poultry," *Arch. f. Entwicklungsmech.,* Bd. XXX., pp. 45–61, 1910 (Roux Festschrift). "Studies on Hybrid Poultry," Ann. Rept. Me. Agr. Expt. Stat., 1910, pp. 84–116.

scribed the results in the F_1 generation of crossing reciprocally Barred Plymouth Rock and Cornish Indian Game fowls. In these papers it was shown that the type of barred pattern seen in Barred Plymouth Rocks appeared to be inherited in a sex-limited manner, the females of the breed mentioned being heterozygous in respect to the factors determining both sex and the barred pattern. These experiments have been continued and it is our purpose in this paper to present the evidence obtained in the F_2 generation, which is in complete accord with the hypothesis of sex-limited inheritance adduced to account for the F_1 results. In this paper the inheritance of the barred pattern in these crosses will be alone discussed. In a later paper other characters, including fecundity, shank color, etc., will be considered.

At the outstart it should be recalled that in the F_1 generation of this cross, but one type of non-barred birds appeared. These were the females resulting from the cross C.I.G. ♂ × B.P.R. ♀. These were solid black birds. In the F_2 generation *three* main types of *non-barred* birds appeared. These were: (*a*) solid black birds, like those in F_1, (*b*) solid white birds, and (*c*) birds showing the game pattern and type of coloration. In the present discussion all of these birds will be considered *together,* as non-barred, *i. e.,* lacking the barred pattern. While they are different among themselves they are alike in this point: they lack the barred pattern. The analysis of these different types of non-barred birds will be considered in detail in a later paper.

Confining our attention here then to the two main categories of birds *with,* and birds *without,* the barred pattern, we have the results set forth below. It will be noted that all possible matings of the F_1 crosses *inter se* and with the parent birds, were made in the experiments.

Using the following symbols,

B = presence of the barred pattern,
b = absence of the barred pattern,
F = presence of the ♀ sex,
f = presence of the ♂ sex,

we have the following constitutions of the birds used, the assumption being made that both B and F can not exist together in the same gamete:

Pure Barred Rock ♂ = $Bf \cdot Bf$,
Pure Barred Rock ♀ = $Bf \cdot bF$,
Pure Cornish Indian ♂ = $bf \cdot bf$,
Pure Cornish Indian ♀ = $bf \cdot bF$.

This leads to the following expectation in the

F_1 Generation:

Mating: *B.P.R.* ♂ × *C.I.G.* ♀.

Expectation:

$Bf \cdot Bf \times bf \cdot bF = Bf \cdot bf$ = Barred ♂♂,
$+ Bf \cdot bF$ = Barred ♀♀.

Mating: *C.I.G.* ♂ × *B.P.R.* ♀.

Expectation:

$bf \cdot bf \times Bf \cdot bF = bf \cdot Bf$ = Barred ♂♂,
$+ bf \cdot bF$ = Non-barred ♀♀.

It was shown in the papers already referred to that these expectations were realized experimentally in the F_1 generation.

We come now to the

F_2 Generation.

I. Mating: *Pure B.P.R.* ♂ × *F_1 Barred Cross-bred*[3] ♀.

Expectation:

$Bf \cdot Bf \times bf \cdot bF = Bf \cdot bf$ = Barred ♂♂,
$+ Bf \cdot bF$ = Barred ♀♀.

[3] After careful consideration it has seemed to the writers advisable to use the term "cross-bred" to designate the offspring from crosses of different *breeds* of poultry, instead of the term "hybrid," reserving the latter to designate the progeny of species crosses. This was the usual connotation of the word "hybrid" before the rediscovery of Mendel's laws. While "hybrid" has the sanction of "good biological usage" at the present time as applied to all sorts of crosses, it seems desirable in the interests of precision of diction in scientific work to use different terms for the progeny from crosses of closely related and more distantly related forms. "Cross-bred" is a term of unmistakable meaning and has long been employed by breeders of domestic animals with the sense in which it is here used. It is unfortunate that we do not have in English in a single word a polite equivalent of the German "*Bastard*" for use in such cases.

The expectation here is that all the offspring, both ♂ and ♀, will be barred.

Experimental Result.—There were 9 matings of this kind made. From these matings were produced 62 ♂ and 61 ♀ chickens.[4] All were barred.

II. Mating: *Pure B.P.R.* ♂ × *Non-barred* F_1 *Cross-bred* ♀.

Expectation:

$Bf \cdot Bf \times bf \cdot bF = Bf \cdot bf$ = Barred ♂♂,
$+ Bf \cdot bF$ = Barred ♀♀.

The expectation here is that all the progeny, both ♂ and ♀, will be barred.

Experimental Result.—There were 9 matings of this kind made. From these matings were produced 27 ♂ and 37 ♀ chickens. All were barred.

III. Mating: *Pure C.I.G.* ♂ × *Barred* F_1 *Cross-bred* ♀.

Expectation:

$bf \cdot bf \times Bf \cdot bF = bf \cdot Bf$ = Barred ♂♂,
$+ bf \cdot bF$ = Non-barred ♀♀.

The expectation here is that all the ♂ progeny will be barred and all the ♀ non-barred.

Experimental Result.—There were 4 matings of this kind made. From these matings were produced 53 ♂ chickens—all barred—and 56 ♀ chickens—all non-barred.

IV. Mating: *Pure C.I.G.* ♂ × *Non-barred* F_1 *Cross-bred* ♀.

Expectation:

$bf \cdot bf \times bf \cdot bF = bf \cdot bf$ = Non-barred ♂♂,
$+ bf \cdot bF$ = Non-barred ♀♀.

The expectation here is that all the progeny, both ♂ and ♀, will be non-barred.

Experimental Result.—There were 4 matings of this kind made. From these matings were produced 19 ♂ and 16 ♀ chickens, all non-barred.

V. Mating: F_1 *Cross-bred* ♂ × *Pure B.P.R.* ♀.

Expectation:

$Bf \cdot bf \times Bf \cdot bF = Bf \cdot Bf$ = Barred ♂♂,
$+ bf \cdot Bf$ = Barred ♂♂,
$+ bf \cdot bF$ = Non-barred ♀♀,
$+ Bf \cdot bF$ = Barred ♀♀.

The expectation here is that all the ♂ progeny will be barred, and that of the ♀ progeny one half will be barred and one half non-barred.

Experimental Result.—There were 6 matings of this kind made. From these matings there were produced 38 ♂ and 32 ♀ chickens. All the ♂♂ were barred, and of the ♀♀ 13 were barred and 19 were non-barred.

VI. Mating: F_1 *Cross-bred* ♂ × *Pure C.I.G.* ♀.

Expectation:

$Bf \cdot bf \times bf \cdot bF = Bf \cdot bf$ = Barred ♂♂,
$+ bf \cdot bf$ = Non-barred ♂♂,
$+ Bf \cdot bF$ = Barred ♀♀,
$+ bf \cdot bF$ = Non-barred ♀♀.

The expectation here is that barred and non-barred birds will appear in equal numbers in both ♂ and ♀ progeny.

Experimental Result.—There were 6 matings of this kind. From these matings were produced 14 ♂ chickens, of which 9 were barred and 5 non-barred, and 23 ♀ chickens, of which 4 were barred and 19 non-barred.[5]

VII. Mating: F_1 *Cross-bred* ♂ × *Barred* F_1 *Cross-bred* ♀.

Expectation:

[4] In this and all of the following cases the numbers of offspring given denote the number which survived until such time as they bore *adult* plumage. It is impossible to make use of chicks in the down plumage in the study of inheritance of barring, because the barred pattern does not appear in the down feathers at all but only in the adult plumage. A full discussion of this point will be found in our first paper on the subject (*loc. cit.*). In general the use of chicks in the down plumage for the study of the inheritance of pattern and color characters in poultry is open to very serious criticism. The reason for this is that in many cases there is no *definite* or *fixed* relation between the color of the chick in the down and in the adult plumage. A chick which is pure white in the down may be black as an adult: a chick which shows the down characters of a Barred Rock may have the adult pattern of a Game and so on. A full discussion of this point, with definite statistical data will be presented in a later paper.

[5] For the probable explanation of this and other deviations from the expected *ratio* in the case of the ♀♀, see below.

$Bf \cdot bf \times Bf \cdot bF = Bf \cdot Bf =$ Barred ♂♂,
$+ bf \cdot Bf =$ Barred ♂♂,
$+ Bf \cdot bF =$ Barred ♀♀,
$+ bf \cdot bF =$ Non-barred ♀♀.

The expectation here is that all the ♂ progeny will be barred and of the ♀ progeny one half will be barred and one half non-barred.

Experimental Result.—There were 9 matings of this kind made. From these matings were produced 69 ♂ chickens—all barred—and 66 ♀ chickens, of which 29 were barred and 37 non-barred.

VIII. Mating: *F_1 Cross-bred* ♂ × *Non-barred F_1 Cross-bred* ♀.

Expectation:

$Bf \cdot bf \times bf \cdot bF = Bf \cdot bf =$ Barred ♂♂,
$+ bf \cdot bf =$ Non-barred ♂♂,
$+ Bf \cdot bF =$ Barred ♀♀,
$+ bf \cdot bF =$ Non-barred ♀♀.

The expectation here is that barred and non-barred birds will appear in equal numbers in both ♂ and ♀ progeny.

Experimental Result.—There were 8 matings of this kind made. From these matings were produced 58 ♂ chickens, of which 27 were barred and 31 were non-barred, and 39 ♀ chickens, of which 13 were barred and 26 were non-barred.

This completes the total number of possible matings. The experiments include all told 670 adult recorded F_2 chickens.

Discussion of Results.—From the results above set forth it is apparent that *as regards the appearance of the different types of birds in the different matings, theory and fact are in close accord in all cases.* More precise and clear-cut results than have been obtained in this experiment would be difficult to find. The precision and definiteness of the results is emphasized by the fact that *in every case an objective description of the bird was made and recorded without any knowledge on the part of the describer of its pedigree or the characters which it would theoretically be expected to bear.* No attempt was made even to work out in the laboratory the theoretical F_2 expectations until after all the data (description of birds) were collected. In fact these F_2 expectations which appear above were never set down on paper by any one in this laboratory until late this present fall, after all the experimental results were collected and tabled. The objectivity of the work could not have been more thoroughly safeguarded. All the original descriptions of the birds were made by the same person, R. P.

There is one point in regard to which it might at first be thought that there was serious disagreement between theory and fact. It will be noted that in matings V., VI., VII. and VIII., there is in each case a more or less marked discrepancy between the expected and the actual numbers of barred female progeny. In matings V. and VII. the discrepancies are small, and may easily be explained as purely chance deviations. In the cases of more serious discrepancy, as well as in these two, the number of barred females actually found is in each case smaller than the expected number. The explanation of this is probably *not* that we have here an exception to Mendelian expectation. On the contrary we have every reason to believe that the explanation is much simpler and consists mainly in the fact that barred females were systematically stolen from the plant during the summer. As has been said it is necessary in working with the barred pattern to wait until the birds are in adult plumage before they can be recorded. Now it happens that, fortunately or unfortunately, the Maine Stations Barred Rock stock is locally held in high esteem for its economic qualities. The location of the houses upon the range this year, and other circumstances as well, made it impossible to control thieving, and a large number of birds were lost in this way. The majority of the barred F_2 cross-bred females were indistinguishable from pure Barred Rock females to a casual observer. Many of them were undoubtedly stolen on the supposition that they were pure Rocks. A careful and thorough study of the evidence has left no doubt in our minds that the above is an important factor in the explanation of the discrepant ratios. Every experimentalist will appreciate our feelings when the discovery of these depredations was made. The whole case illustrates very well the condition which one working in a state agricultural institution is liable at any time to be

confronted with, because of the fact that, owing to public opinion, he can not enforce stringent and drastic measures to guard against the stealing of such things as chickens and eggs.

One further fact to which we wish to call attention here has to do with the character of the barring exhibited by certain of the F_2 birds. In the paper describing the F_1 birds special stress was laid on the fact that the barring in these birds was not of such fine quality from the fancier's standpoint as in pure Barred Rocks. No one familiar with good specimens of that breed could ever mistake a barred F_1 bird for a pure Rock. In certain of the F_2 birds this is not the case. Certain of the F_2 matings produced birds which had a much finer, sharper and cleaner cut barred pattern, or, to adopt a technical expression, a "snappier" barring than any pure Barred Rock in the Station stock. In other words, it appears that though the heterozygous nature of the F_1 birds was apparent in their external characters, the segregation of barred pattern in the F_2 generation was not merely perfect, but, to speak paradoxically, was more than perfect, *i. e.*, produced something better than existed in the parent stock. It may be said, in passing, that the same thing is true with reference to comb types. In the F_1 generation there were very few *perfect* pea combs, from the fancier's standpoint. In the F_2 generation where pea combs segregated out relatively many of them were of fine showroom quality, and relatively few were badly defective or intermediate between pea and single. The relation of the individuality of the birds bred to the quality of the segregation products furnishes an exceedingly interesting and important problem.

One further point needs mentioning. In the F_1 generation the male birds produced by the cross of B.P.R. ♂ × C.I.G. ♀ and its reciprocal were all alike in gametic formula and external appearance. The F_2 results indicate that the same results were obtained with F_1 males from the cross B.P.R. ♂ × C.I.G. ♀ as with those obtained from the cross C.I.G. ♂ × B.P.R. ♀. These two kinds of males were, in other words, equivalent in fact as well as in theory.

In later papers the details of the results here briefly reported will be presented, and a discussion of the different types of non-barred birds and the laws of their appearance entered upon.

By way of summary it may be said that experiments involving 670 adult birds in the F_2 generation, arising from all possible matings of F_1 birds *inter se* and with the parent pure breeds (Barred Plymouth Rock and Cornish Indian Game) give results in regard to the inheritance of the barred color pattern which are in accord with a Mendelian hypothesis of sex-limited inheritance of this character, developed along lines originally suggested by Spillman.

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November 21, 1910

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The eleventh annual meeting of the Astronomical and Astrophysical Society of America was held at Harvard College Observatory, Cambridge, Mass., on August 17, 18 and 19. The society was welcomed to Cambridge by Professor E. C. Pickering, both in his capacity as president and as director of the observatory. Among those present were more than a score of foreign astronomers and physicists, who had come to this country for the purpose of attending this meeting and later that of the International Union for Cooperation in Solar Research at Mount Wilson in California. The complete list of those in attendance is as follows: Miss Allen, Miss Breslin, Miss Cannon, Miss Carpenter, Miss Cushman, Mrs. Fleming, Miss Harwood, Miss Hayes, Miss Leavitt, Miss Leland, Miss O'Reilly, Miss Walker, Miss Waterbury, Mrs. Whitin, Miss Whiting, Messrs. Apple, Archer, Backlund, Bailey, Barton, Bell, Belopolsky, L. Brown, L. Campbell, Cirera, Coit, Comstock, Cortie, Cotton, Dinwiddie, C. L. Doolittle, Douglass, Dugan, Duncan, Dyson, Edwards, Eichelberger, Fabry, Fisher, Fowler, Gimenez, Hepperger, Hills, Humphreys, Hunt, Hussey, E. S. King, Larmor, C. Lundin, C. A. R. Lundin, Man-

son, Metcalf, Milham, D. C. Miller, S. A. Mitchell, Newall, Parkhurst, Peirce, Peters, E. C. Pickering, W. H. Pickering, Plaskett, J. M. Poor, Pringsheim, Ricco, Roe, Rotch, Russell, Rydberg, Schwarzschild, Schlesinger, Skinner, Stebbins, Stetson, Turner, Updegraff, Upton, Very, Wendell, Whitman, Willson, Wolfer and W. L. Wright.

The following persons were elected to membership: Miss Leah Brown Allen, Wellesley, Mass.; Professor A. T. C. Apple, Lancaster, Pa.; Father Peter Archer, S.J., Georgetown University; Dr. Oskar Backlund, Pulkowa, Russia; Miss Louise Brown, Wellesley, Mass.; Professor Robert E. Bruce, Boston University; Mr. A. J. Champreux, Berkeley, Cal.; Professor Wilbur A. Coit, Acadia University, Wolfville, N. S.; Professor A. E. Douglass, University of Arizona; Dr. J. C. Duncan, Harvard University; Mr. F. W. Dyson, Royal Observatory, Greenwich, England; Mr. Sturla Einarsson, Berkeley, Cal.; Mr. Charles Grosjean, Omaha, Nebraska; Miss Margaret Harwood, Littleton, Mass.; Miss Ellen Hayes, Wellesley, Mass.; Professor Josef v. Hepperger, Vienna, Austria; Mr. Charles John Hudson, Clinton, Mass.; Miss Jennie B. Lasby, Pasadena, Cal.; Mr. C. A. Robert Lundin, Jr., Cambridgeport, Mass.; Mr. P. G. Nutting, Washington, D. C.; Mr. W. F. Meyer, Berkeley, Cal.; Professor W. I. Milham, Williamstown, Mass.; Miss Mary Proctor, New York City; Mr. R. F. Sanford, Mt. Hamilton, Cal.; Professor Karl Schwarzschild, Potsdam, Germany; Mr. Elihu Thomson, Swampscott, Mass.; Professor H. H. Turner, Oxford, England; Mr. Percy F. Whisler, Urbana, Ill. It will be noticed that this list contains the names of several foreign astronomers, a gratifying innovation that is likely to prove of considerable importance to the society.

Most of the sessions were as usual devoted to the reading and discussion of papers, but time was found for several pleasant and instructive excursions to points of scientific interest in the vicinity of Cambridge; thus on the afternoon of the seventeenth a visit was paid to the meteorological observatory at Blue Hill, where Director Rotch exhibited the equipment and explained the work of the institution. On the afternoon of the eighteenth the society went in a body to the Whitin Observatory of Wellesley College and on the nineteenth to the Students' Observatory of Harvard College; these two visits were of particular interest to those who are engaged in teaching, as Professor Willson and Miss Whiting, who are in charge of these observatories, have highly developed the "laboratory method" in astronomy. In addition ample opportunity was given to the members to examine the equipment of Harvard Observatory itself, and for this purpose the whole staff of the observatory very kindly put their time at the disposal of the visitors.

The following papers and reports were read at the various sessions:

Some Preliminary Results deduced from Observed Radial Velocities of Stars: W. W. CAMPBELL. (Read by Mr. Plaskett.)

From the radial velocities of more than one thousand stars, observed for the most part at the Lick Observatory and at its southern station in Chile, the following results were obtained for the location of the apex of the sun's way:

Right ascension, 272°.0 ± 2°.5.
Declination + 27°.5 ± 3°.0.
Velocity of the sun in space, 17.77 km.

The last is somewhat smaller than was expected in view of the author's earlier value from 280 stars and that of Hough and Halm. The data could, however, not be made to yield a sensibly greater value; 330 stars of spectral types O, B, A and F (up to F4) yielded 17.69 km., while 704 stars of types F5 to G, K and M gave 17.96.

The stars were tabulated with regard to spectral types and it was found that their velocities increase as the type advances, those of B type having an average velocity of 9.0 km.; A type, 10 km.; F, 14 km.; G and K, 15 km., and M, 16.5 km.

A study of 280 velocities made by the author in 1900 had indicated a progressive decrease in velocity with increasing brightness; a similar study of the fourfold more extensive material now at hand does not confirm the earlier result, which seems to have been due to the larger proportion of first-type spectra in the earlier data.

The author showed that Kapteyn's discovery of systematic drifting, deduced from the study of proper motions, was clearly and strongly confirmed by the radial velocities. Stars in the neighborhood of Kapteyn's vertex and antivertex appear to have velocities about 33 per cent. greater than stars that are about 90° from these points.

A study of radial velocity in connection with proper motions indicates that stars of different spectral types and likewise of different magnitudes are more thoroughly mixed, that is more nearly equal in distance, than has previously been supposed; and that the brighter stars, down to the fifth magnitude, are nearer to us than the formulæ for mean parallaxes would place them.

The systematic study of spectroscopic binaries led to interesting conclusions which have since been published in Lick Observatory Bulletins, Volume 6, p. 17.

Items as to New Spectroscopic Binaries: Edwin B. Frost and Oliver J. Lee. (Read by Mr. Parkhurst.)

Particulars were communicated regarding the following twenty spectroscopic binaries, recently detected at the Yerkes Observatory: σ Andromedæ, B. D. 59°.146, 86 ρ Tauri, μ Eridani, ω Orionis, ν Geminorum, 42 Camelopardalis, ϕ Geminorum, γ Cancri, θ Hydræ, σ Leonis, 23 Comæ, η Coronæ, ι Serpentis, γ Coronæ, π Serpentis, 68 Ophiuchi, 13 Vulpeculæ, 33 Cygni, 16 Lacertæ.

Probable Errors of Radial Velocity Determinations: J. S. Plaskett.

This paper presents the results of the measures of a number of plates of the same star with three different dispersions, a three-prism spectrograph with a long focus and a short-focus camera and a single-prism spectrograph, whose linear dispersions are approximately as 3, 1½, 1. It is shown that the probable error of a plate by no means increases proportionately with decrease of dispersion, but that, so far as these results go, probable error is only increased about 40 per cent. for a decrease of dispersion from 3 to 1. A discussion of these results is followed by a consideration of the effect of change of spectral type, with the consequent change in the number and quality of the lines measured, upon the errors of radial velocity determinations. A tabulation of the probable errors of single plates obtained in the determination of numerous spectroscopic binary orbits shows how closely these errors depend upon the quality of the lines for measurement.

Visual and Photographic Magnitudes, Colors and Spectral Types of the Stars to Magnitude 7.5 in the Zone between 73 and 77 Degrees North Declination: J. A. Parkhurst.

The photographic determination of star-colors and their relation to spectral types was begun in 1906 at the Yerkes Observatory by F. C. Jordan and the writer. In March, 1908, work was begun on a zone centered at + 75°, with the idea of extending it to the pole. The present paper describes the results for the stars between + 73° and + 77°, 290 in number. All the work was photographic, using a Zeiss doublet of 145 mm. aperture and 814 mm. focal length. The photographic magnitudes were taken from Seed plates exposed 6 mm. from the focus, giving extra-focal images 1.2 mm. in diameter. The opacity of these images was measured with a Hartmann surface photometer so calibrated as to give magnitudes on an absolute scale. The "visual" magnitudes were obtained from micrometer measures of the diameters of focal images taken on Cramer trichromatic plates, using a "visual luminosity" filter. The magnitudes are based on the system of the Potsdam *Photometric Durchmusterung.* The spectral types were estimated from plates taken with a 15° objective prism over the same doublet. The Harvard classification was used. The probable error of a catalogue magnitude is ± 0.03 for the photographic, and ± 0.04 for the visual values. The color-perception of the plates is a little less than the Potsdam, and about equal to the Harvard catalogues. The color-spectrum curve is steeper than that given in Vol. 59 of the *Harvard Annals.*

An Independent Method of Determining the Extra-tellurio Solar Radiation: Frank W. Very.

Static methods in actinometry are at present in disrepute on account of the difficulty of obtaining accurate values of the instrumental corrections. The proposed method overcomes this objection by completely eliminating the most troublesome of these corrections. There remain only theoretical difficulties, and some of these will continue to exist by whatever method we may approach the problem. A recent new determination of the melting point of platinum by Day and Susman fixes its value at 2048° C. Abs. within 5°. If we expose a strip of thinnest platinum, coated with platinum black, to the solar rays at the focus of a condensing mirror, and gradually increase the aperture of the mirror by opening an iris diaphragm, having first heated the foil until the conduction into the supports has assumed a steady state, which will require about two minutes, a point is reached where a further increase of the aperture will almost instantly melt the platinum. The experiment avoids the necessity of applying an uncertain correction for loss of heat by convection, because, owing to the viscosity of air at high temperatures and the slow motion of the air, the loss by convection in the time required to melt the platinum is negligible. The temperature of the environment need not be considered, since radiation at ordinary temperatures is insignificant compared with that of melting platinum. The platinum black passes to bright platinum in melting, but lasts long enough for the purpose of the comparison, which gives the means of confronting for an instant surfaces which are more nearly

comparable than those of an ordinary actinometer and the sun. The experiment has been performed in a preliminary way by Professor J. M. Schaeberle, using a silver-on-glass concave mirror of his own construction, as described by him in SCIENCE for December 20, 1907. Professor Schaeberle has communicated to the author details of the operation, which gives the following result: using Stefan's formula for total radiation of a black body with Kurlbaum's constant, the temperature of a "black" sun is 6563° C. Abs., and the solar constant = 3.05 calories.

On the Need of Adjustment of the Data of Terrestrial Meteorology and of Solar Radiation, and on the Best Value of the Solar Constant: FRANK W. VERY.

In this paper Professor Very first points out that owing to the complexity of the field of terrestrial meteorology and the uncertainty of some of its data, compromise and adjustment are necessary if we are to have a consistent theory. The great importance of the solar constant and the impossibility of observing it directly, demand unusual care; attention must be paid to the principle that the adopted value must not violate other facts of observation that rest on a firmer basis than the constant itself. The paper goes on to criticize certain phases of the work of Abbot and Fowle in volume II. of the *Annals of the Astrophysical Observatory of the Smithsonian Institution*, more especially their virtual assumption that the transmission of telluric radiation by our atmosphere varies in proportion to an experimental coefficient raised to a certain power depending upon the mass of aqueous vapor in the transmitting column. As a consequence of this and some other points of hardly less importance, Professor Very believes that the value of the solar constant deduced by the Smithsonian observers is much too small and that the true value exceeds three calories; and further that this higher value of the constant reconciles meteorological and astrophysical data which would otherwise be incompatible. It is not possible within the narrow limits here allowable to summarize adequately this important paper, which it is hoped will soon be published in full.

The Lick Observatory Photographs of Halley's Comet: H. D. CURTIS. (Read by Professor Comstock.)

In the interval between September 12, 1909, and July 7, 1910, 370 photographs were secured on 95 nights; 206 of these were taken with the Crossley reflector, 120 with either a 5¼-inch or a 6-inch portrait lens, and 44 with short-focus camera lenses. These auxiliary cameras were all mounted on the tube of the reflector and the guiding was accomplished by means of a 3.5-inch finder of 211.5 inches focal length. The Crossley plates are of great interest in the amount of material they furnish for the study of the envelopes and other features in the head, which varied greatly from night to night. Photographs taken with the smaller cameras are chiefly useful in a study of the tail, which was photographed up to 28° from the head.

The Society's Expedition to Hawaii for Photographing Halley's Comet: FERDINAND ELLERMAN. (Read by Professor Comstock.)

After a short reconnaissance Mr. Ellerman selected a site on the south slope of Diamond Head, five miles southeast of Honolulu. The first photograph was secured on April 14, 1910, and the last on June 11. In all 58 negatives were secured with the 6-inch Brashear doublet and 11 with a 2¼-inch Tessar, on 36 different dates. The paper was illustrated with many slides that brought out very clearly the interesting changes in the comet's appearance that occurred toward the end of May and early in June.

On the Motion of the Particles in the Tail of Halley's Comet on June 6, 1910: E. E. BARNARD. (Read by Mr. Parkhurst.)

The photographs on this date show a discarded tail drifting away from the comet. The rear end of this receding tail was measured with respect to the head on three photographs taken respectively at Williams Bay, Honolulu, and Beirut, Syria. The last two were made by Mr. Ellerman and Mr. Joy. The Greenwich mean times of these photographs are June $6^d\ 15^h\ 49^m$, $20^h\ 4^m$ and $30^h\ 58^m$.

Williams Bay *minus* Honolulu, motion per second from head, 23.0 miles.

Williams Bay *minus* Beirut, motion per second from head, 33.5 miles.

Honolulu *minus* Beirut, motion per second from head, 37.4 miles.

The comet's motion away from the sun was 16.6 miles per second. Hence the motions of the mass with respect to the sun were, respectively, 39.6, 50.1 and 54.0 miles per second. These show a decided acceleration of the motion of the mass.

Some Results with a Selenium Photometer: JOEL STEBBINS.

After a considerable amount of experimenting,

the selenium photometer has been perfected so that bright stars can be measured more accurately than by either visual or photographic methods. With a selenium cell attached to the 12-inch refractor, an exhaustive study of the light-curve of Algol has been made, with special attention to the constancy of the light at maximum. It has been found that Algol is a star of continuous variation, the light-curve showing both a secondary minimum and changing light between minima. From these observations new elements have been derived, which indicate that the companion, which has often been considered a dark body, in reality gives more light than our own sun; and in addition is much brighter on the side which is turned toward Algol, due presumably to the heating effect of the intense radiation which is received from the primary. A complete account of this work is to be published in the *Astrophysical Journal*.

Note on the System of Algol: R. H. Curtiss. (Read by Professor Stebbins.)

Observations employed in a paper by the author, published in the *Astrophysical Journal*, **28**, 150, suggest a variation in the period of revolution of the center of mass of the eclipsing pair of Algol, about the center of mass of the system. Tisserand's hypothesis as to the rotation of the line of apsides of the orbit of the eclipsing pair is still consistent with the facts. On the basis of this hypothesis and Chandler's elements with Vogel's well-known data, the period of rotation of Algol must lie between 0 days and 4.23 days with a probable value equal to the light period. Rejecting the assumptions of Vogel and Tisserand, limiting values of the oblateness of figure of the eclipsing stars are computed, the identity of the rotation and light periods being assumed. Certain constants of the system are computed on the basis of Vogel's data.

A new Sixteen-and-one-fourth-inch Doublet: Joel H. Metcalf.

This doublet has been constructed by the writer and is now mounted at the Harvard Observatory. The glass is of the general form of the Petzval-Voigtlander type working with an aperture of *f* 5.5. Its special features are (1) the use of dense flint (Series O of Parra Mantois) instead of the light flint usually employed in these constructions. This reduces the steepness of the curves, the thickness of the lenses and the resultant curvature errors. The glass is very transparent and free from veins as well as finely annealed. (2) Astigmatism has been almost entirely eliminated so as to secure round star images suitable for measurement all over the field. This has been done even at the expense of some flatness of the field which has been corrected in another way. (3) The careful elimination of coma. This has been done by theory and the residual amount neutralized by the spacing of the front and back combinations by actual experiment. (4) The spherical aberration of the second and fourth orders has been eliminated by theory and the careful spacing of the lenses of the front combination. This has been done for the spectrum in the region of the *G* line by the use of nearly monochromatic light in testing. The fourth order aberration has been eliminated by local polishing or parabolizing the front surface of the first crown lens. The errors remaining are a slight curvature of the field which has been practically eliminated by Professor Pickering by the use of plates mechanically bent to the proper curvature. The one remaining appreciable error in a field of eight or ten degrees is the secondary color correction which is inherent in all lenses made of the ordinary crown and flint glass. In a lens of such great absolute and relative aperture this error is quite marked, as the enlargement of the images of bright stars shows. Unless the use of other glasses will materially reduce this secondary spectrum it would seem useless to construct doublets of greater size with such large relative aperture, for the effect would be to increase the scale of the picture without giving greater space-penetrating power.

Solar Prominences Photographed with the Rumford Spectroheliograph of the Yerkes Observatory: Frederick Slocum. (Read by Mr. Parkhurst.)

This paper consisted of: (1) A series of photographs of a large quiescent prominence observed from March 4 to April 28, 1910 (two rotations of the sun). Maximum height 106″ = 77,000 km. Maximum lateral extent, 47° of the sun's limb = 57,000 km. (2) A series of photographs of a very active prominence observed on March 25, 1910. Beginning as a small insignificant cone, this prominence developed rapidly, and in a few hours vanished at a height of 7′.4 = 320,000 km., after having passed through a variety of fantastic shapes. (3) Miscellaneous photographs of prominences obtained at the Yerkes Observatory during the past few years.

An Instrument for Rapidly Solving Spherical Triangles: F. W. Dyson.

This has been made by Mr. W. B. Blaikie, of Edinburgh; it is very simple and ingenious, and is useful when one is only working to half degrees. He has lithographed on two sheets of celluloid stereographic projections of parallels and meridians, the poles in each case being on the circumference. One of these sheets is fixed and the second, which is placed above it, can be turned about a pin at the center. In this way five parts of the triangle can be read off at once.

An Interesting Spectroscopic Binary, 96 Herculis: S. A. MITCHELL.

While at the Yerkes Observatory in the earlier part of this summer, a spectroscopic binary of more than usual interest was found in 96 Herculis, a star of 5.1 magnitude, I 5 type, with many good lines. The first plate measured showed the lines to be triple and the ternary character of the star has been abundantly verified. The results of measures from two plates are as follows:

Plate taken on June 6, 1910.

Component I., radial velocity $= -26$ km. from 18 lines.

Component II., radial velocity $= +25$ km. from 6 lines.

Component III., radial velocity $= +62$ km. from 9 lines.

Component I. is very strong, II. and III. are sharp but faint.

Plate taken on June 24, 1910.

Component A, radial velocity $= -85$ km. from 8 lines.

Component B, radial velocity $= -19$ km. from 16 lines.

Component C, radial velocity $= +33$ km. from 8 lines.

Components A and C are faint, but sharp; B is strong.

Changes are rapid, the period (if such can be said to exist in a three-body system) is a few days.

On the Accuracy of the Star Positions of the Harvard Sky: H. H. TURNER.

The Harvard Sky consists of fifty-five plates, each covering about thirty degrees square. The scale is rather less than one tenth that of the Astrographic Catalogue, a réseau interval of five millimeters corresponding to about fifty-two minutes at the center of the field. The plates are therefore not intended for giving accurate positions, but it is convenient to know what kind of accuracy is obtainable from the plates, and further it is of interest to know the optical distortion of a lens covering such a wide field. Two plates have been partially measured with some care, the measures being confined to the neighborhood of rectangular axes through the plate center. The first plate (R. A. $6^h\ 0^m$; Decl. $0°$) was measured some years ago and an outward optical distortion of $0''.024\ r^3$ was indicated, r being the distance from the plate center expressed in réseau intervals. The second plate was measured recently by Mr. G. H. Hamilton, who used a much larger number of stars than were used before. The value for the distortion was found quite independently to be $0''.030\ r^3$ in one coordinate and $0''.036\ r^3$ in the other. The uncertainty of the determination is due to the confusion with the scale value: for the differences may be written (say) $\pm 0''.006\, r(r^2 - 10^2)$; which does not exceed $2''.3$ between $r = 0$ and $r = 17$. The point on the plate from which this distortion radiates may be approximately identified as follows: Let the coordinates be (a, b) so that the displacement in x is $k(x-a)\{(x-a)^2 + (y-b)^2\}$. The terms in x^2 and xy can arise from tilt of plate; but the term $-kay^2$ can not arise from tilt and enables us to find a. Similarly b can be found from the displacement in y. When this distortion and a slight tilt of the plates are allowed for, the resulting star measures agree closely with the calculated measures; which suggests that if large plates could be made sufficiently flat, large fields might be photographed with accuracy. This object might be attained as follows: Let a large glass surface be carefully planed and ruled with réseau lines; and placed in the focus of a wide angle lens. Several small plates could be placed film down on this surface, to receive the images of the stars and of the portion of the réseau which they covered. They could be developed and measured as separate plates, all accurately connected by the réseau lines of the matrix.

The Photometric Magnitude of Eros in 1903: S. I. BAILEY.

The variability in light of Eros was announced by E. von Oppolzer in 1901. At this time the range of variation was said to be two magnitudes. Observations somewhat later at the Harvard Observatory, by Professor Wendell, showed that at times the range of variation was very small or entirely lacking. At the suggestion of the director of Harvard Observatory, the writer undertook an extensive study of the changes in light

of Eros, at Arequipa, during the opposition of 1903. The instrument employed was one of the Rumford photometers devised by Professor E. C. Pickering and described by Mr. J. A. Parkhurst in the *Astrophysical Journal*, **13**, 249. Observations were carried on from March 30 to August 19, 1910. On many nights the observations were made to cover the full double period of the light changes. The results give a mean period of 5.270 hours, for the double period, or, since the two halves of the curve appear to be precisely equal, a period of 2.635 hours. The period would change by a small amount during this time, but the above period satisfies well all the observations. The range of variation appeared to vary from five tenths to eight tenths of a magnitude, the mean being about six tenths. The brightness of Eros during these observations varied from about magnitude 11 to magnitude 13.5.

The Division Errors of the Nine-inch Transit Circle of the Naval Observatory, and the Effect upon the Division Errors of Refilling the Divisions: W. S. Eichelberger.

Two independent determinations of the division errors were made by Professor Eichelberger for each of the 10,800 graduations. A comparison of these indicates a probable error of 0″.04 for the 2′ marks. For the degree marks the probable error is 0″.018. These determinations were made after the graduations had been refilled; to determine whether they would apply to the 20,000 observations previously made, the observed corrections to the ephemeris declinations of the sun were collected and it was shown that the recently determined division errors were in all probability applicable. A similar result was obtained by discussing the earlier observations of 400 zodiacal stars, and computing the probable error of a declination (1) when the same division had been used for the same star, and (2) when different divisions had been used. These became practically the same only after the recently determined division errors had been applied, and indicated that these errors could have been only slightly altered, if at all, by the refilling of the marks. Professor Eichelberger finds that this circle, like those of the 6-inch transit-circle of the Naval Observatory, shows a periodic error in the 2′ marks that repeats itself every 10′.

The Eclipsing Variable u Herculis: Frank Schlesinger and Robert H. Baker.

In the usual case presented by spectroscopic binaries the masses of the two components, and therefore their densities, remain indeterminate. This is because (1) the inclination of the orbit can not be computed from measures of the radial velocities alone; and (2) it is necessary to know the ratio of the two masses involved before either becomes determinate. Both of these obstacles are removed in the case of such of the eclipsing variables for which both spectra appear upon the plates. Among the stars readily accessible to present-day instruments there are only three that fulfill these conditions: β Lyræ, V Puppis and u Herculis, and only for the last have the necessary observations been made. A discussion of these data shows that the two stars must be very nearly the same size, but that one has a density 2.6 times that of the other and is about 2.5 times as bright. These results have an important bearing on questions of double-star evolution. It was also shown that if the parallax were accurately determined, it would be possible to state whether the surface brightness of these helium stars is greater or less than that of our sun, a question that has been the subject of considerable debate in recent years. This paper will soon appear in volume II. of the Publications of the Allegheny Observatory.

The Rotation of the Sun for Different Substances in the Reversing Layer: Frank Schlesinger.

A series of spectrograms were secured in the fall of 1909 with the new Porter spectrograph of the Allegheny Observatory. This is fed by a vertical cœlostat that forms part of the Keeler reflecting telescope. The dispersing piece is a large Michelson grating with 500 lines to the millimeter. The photographs were taken in the third order and yield a linear dispersion of 0.82 millimeter to the Ångström. Thirty-seven good lines from λ 4059 to λ 4147 were selected and the displacements due to rotation measured on eighteen plates. No difference from the mean greater than 2.4 per cent. was found and a discussion of the residuals made it very probable that differences due to rotation must be much smaller than this. The results showed no systematic tendency for the various lines due to the same substance. There seemed to be a small systematic increase of displacement with increase of wave-length, and the recent observations at Mount Wilson seem to show the same tendency.

The Orbit and Spectrum of o Persei: Frank C. Jordan. (Read by Professor Schlesinger.)

The spectrum of the principal star is of the type B 2, and that of the secondary seems to be

an exact duplicate of the primary except as to brightness. The orbit was computed from seventy plates obtained at the Allegheny Observatory. Ten lines are the maximum number measured for the primary, though twenty-eight others are distinct enough for an approximate determination of their positions. Only seven lines of the secondary can be measured even on the best plates. The ratio of the mass of the brighter star to that of the fainter is 1.43. If the surfaces of the two were of the same brightness per unit area, and the densities the same, the difference in mass would imply a difference of but 0.27 magnitude, which is undoubtedly too small; therefore the secondary is either denser, or its surface brightness is less. The point of special interest in this star is the fact that the calcium lines H and K show constant velocity. K is measurable on sixty plates, from which is derived a mean velocity of + 12.4 km. with a probable error of ± 4.27 km. for an average plate, while the probable error of the mean is ± 0.55 km. If instead of Rowland's wave-length of 3933.825 we use the mean derived from seven first type stars, 3933.768, the velocity becomes + 15.4 km. If we use the value derived by St. John at Mt. Wilson, 3933.667, the velocity is increased to + 25 km. As the velocity of the center of mass of the system is + 18.46 km. it is impossible to say whether the velocity of the calcium vapor is the same or not, but it can not be much different. The H line of calcium gives a velocity of + 18.4 km. or + 29.4 km. depending upon whether we adopt Rowland's or St. John's wave-length. This line is a difficult one to measure because of the proximity of the diffuse He line, and this may account for the difference between its velocity and that of the K line. This paper is to be published in volume II. of the Publications of the Allegheny Observatory.

The Spectrum of the Chromosphere and the Application to it of some Recent Laboratory Investigations: WALTER S. ADAMS and HENRY G. GALE. (Read by Professor S. A. Mitchell.)

The first part of this paper is a continuation of the work of Hale and Adams, *Astrophysical Journal*, **30**, 222, on the photography of the flash spectrum without an eclipse. The number of lines obtained on these plates compares favorably with that afforded by eclipse plates, being much richer in the red but not so rich in the blue. About 97 per cent. of the bright lines can be identified with dark lines in Rowland's table; of the remaining 3 per cent. a few are due to helium. A marked feature of probably *all* the bright chromospheric lines is the tendency to double reversal as the sun's limb is approached; out farther they assume the character of simple bright lines. The enhanced lines, as compared with the arc lines, appear with much greater intensity as bright lines in the chromosphere than as dark lines in the ordinary solar spectrum; this agrees with the previous results of Lockyer, Evershed, Dyson and others. An attempt was made to identify the coronal line at λ 5303.26 ± 0.15; the photographs show a well-marked line at λ 5303.36, but it is probable that this is coincident with the dark line at λ 5303.401 in Rowland's tables.

The second part of the paper is concerned with an investigation of the spectrum of the electric spark under pressure, made by Mr. Gale at the Pasadena laboratory. In the case of titanium it was found that in the region around λ 4300 the arc lines become completely reversed under pressures of five or six atmospheres while the enhanced lines remain bright. On plates taken at longer wave-length, however, some of the arc lines do not reverse, and in general the proportion of unreversed lines increases with the wave-length; this accords with Hale's result in *Astrophysical Journal*, **15**, 227. Similar results have been obtained for iron and chromium, except that higher pressures seem to be necessary to produce the maximum number of reversals. The authors then apply these results to the spectrum of the chromosphere as follows: Fabry and Buisson have shown that the pressure in the sun's reversing layer is between five and six atmospheres, which is the pressure used for most of the above laboratory experiments. We should accordingly expect that the enhanced lines will appear bright in the chromosphere while most of the arc lines remain dark, and this accords with the observed facts. Moreover, as we pass to the longer wave-lengths both the chromosphere and the plates of the spark spectrum taken in the laboratory show an increasing number of arc lines that do not reverse.

Some Results of the Study of the Spectra of Sirius, Procyon and Arcturus with High Dispersion: WALTER S. ADAMS. (Read by Mr. Plaskett.)

The material discussed by Mr. Adams in this paper consists of six plates of Sirius extending from λ 4200 to λ 6600, four of Procyon from λ 4200 to λ 4900, and nine of Arcturus from λ 4300 to λ 6600. These were secured with an auto-collimating prism spectrograph of 18 feet

focal length, yielding much higher linear dispersion than is usually employed in stellar work. The spectrograph was placed in a constant temperature-room and was fed by the 60-inch reflector of the Mount Wilson Observatory in the coudé form. These spectrograms were studied with a view to obtaining some knowledge of the pressures in the atmospheres of these stars. For this purpose the relative shifts with respect to an iron arc comparison spectrum were measured for the enhanced lines and also for the arc lines. The basis for this distinction is Mr. Adams's earlier work on the displacements, in all probability due to pressure, of lines at the limb of the sun; in this work he had found that the large displacements were as a rule associated with the enhanced lines, and small displacements with arc lines. For the three stars studied Mr. Adams finds:

Sirius,	enhanced lines	*minus*	arc	lines	+ 0.014 Å
Procyon,	"	"	"	"	+ 0.009
Arcturus,	"	"	"	"	+ 0.001

Furthermore in Arcturus, whose spectrum closely resembles that of a sun-spot, it was found that only the iron lines show a shift in the positive direction, that is 0.006 Å toward the red; while the lines of nickel, titanium, vanadium, magnesium, calcium and hydrogen were in this order shifted toward the blue, hydrogen most of all. The principal inferences that the author draws from these results are that the cause of these systematic shifts in stellar spectra is the same as that which is effective at the limb of the sun, and that accordingly in all probability they are due to pressure. On this basis it becomes possible to compute the pressures in the atmospheres of these stars as compared with that of our sun. For Sirius this comes out twelve atmospheres (terrestrial) greater than that of the sun, and for Procyon seven atmospheres. For Arcturus an arrangement of the different gases similar to that in the sun is indicated; hydrogen, calcium and magnesium being at the level of low pressures and iron in the region of high pressures.

Note on the Spectrum of D. M. + 30° 3639: Walter S. Adams. (Read by Professor Hussey.)

In 1892 Campbell found this star, whose magnitude is 9.3, to be surrounded by a hydrogen atmosphere 5″ in diameter. With a one-prism spectrograph (attached to the 60-inch reflector) and an exposure of 150 minutes, Mr. Adams succeeded in securing a satisfactory spectrogram of this faint star. The hydrogen lines from Hβ to Hζ are visible and extend beyond the continuous spectrum by an amount that precisely corresponds to Campbell's estimate of 5″. The bright line at λ 4068 also extends outward about 4″; the origin of this line is unknown. This is also true of the extremely bright band at λ 4652, which does not extend beyond the continuous spectrum. A less satisfactory spectrogram had been obtained on an earlier evening; and a comparison of the two indicates that the velocity of the star is probably variable.

Note on D_3 in the Spectrum of Prominences: Jennie B. Lasby. (Read by Miss Whiting.)

No photographic determination of the wave-lengths for the two components of D_3 in the sun appears to have been published. Four plates were secured by Mr. Adams on August 28 and December 15, 1908, when large prominences were visible; these were measured by Miss Lasby and also by Mr. Adams, and the wave-lengths were determined as 5875.841 and 5876.190, which are in good agreement with Mohler and Jewell's visual observations of the sun and also with their laboratory measures. Miss Lasby advances reasons against the supposition that D_3 is present as a dark line in the ordinary solar spectrum.

On the Determination of the Elements of Algol Variables: Henry Norris Russell.

In the first approximation, an Algol variable may be assumed to consist of two spherical stars, each of uniform surface brightness, revolving in a circular orbit. If the eclipse is total, that is, if there is a constant period at minimum, the actual brightness of each of the stars is at once known. Three unknowns have then to be found: the radius R of the eclipsing star, in terms of that of the orbit; the ratio κ of the radius of the eclipsed star to that of the other; and the inclination i of the orbit. Let θ be the orbital longitude of the eclipsing body, measured from the point of conjunction. Its value at the instant when any given percentage of the area of the eclipsed star is obscured may be found from the light-curve. If ρ is the apparent distance of the centers at this moment, we have from geometrical considerations $\rho^2 = \sin^2 i \sin^2 \theta + \cos^2 i$; and from the known eclipsed area $\rho = Rf(\kappa)$ where $f(\kappa)$ is a transcendental function, which can be computed for any given value of κ. Hence $R^2\{f(\kappa)\}^2 = \sin^2 i \sin^2 \theta + \cos^2 i$. From three such equations, corresponding to different percentages of obscuration, R and i may be eliminated, giving an equation of the form

$$\phi(\kappa) = \frac{\sin^2\theta_1 - \sin^2\theta_2}{\sin^2\theta_2 - \sin^2\theta_3}.$$

Tables have been prepared giving the values of $\phi(\kappa)$, taking θ_2 and θ_3 to correspond to obscurations of 60 and 90 per cent., and θ_1 to a number of values from 0 to 100 per cent. From each observed value of θ_1, κ may thus be determined. If the values so found are not in agreement, they may be improved by small modifications of the assumed θ_2 and θ_3. In this way a light-curve may be found which represents closely the whole course of the observations. When κ is known, R and i are very easily found. The whole computation of the elements can be made in less than an hour. When the eclipse is partial, the relative brightness of the two stars is also unknown. By assuming two or three values of this, light-curves may be computed as above, and the best value found by interpolation. If a secondary minimum exists, the eccentricity of the orbit and longitude of periastron may also be found by well-known methods.

Some Hints on the Order of Stellar Evolution: HENRY NORRIS RUSSELL.

Let it be assumed that a star grows denser as it advances in evolution; that it is in equilibrium under its own gravitation, without sensible external disturbance; and that the material of which it is composed behaves like the gases with which we are familiar. It has been shown by Ritter and others that such a star will grow hotter as it contracts (Lane's law) until its density reaches a critical value, probably between those of air and water, and nearer the latter. The temperature then reaches a maximum and later decreases. The most massive stars will reach the highest temperature at maximum. This is true of both surface and internal temperatures, the latter suffering the greater relative changes. Those stars that are hottest at any given time will, therefore, be more massive than the average. Stars whose surface temperature has a given value less than the maximum will be of two kinds —one early in evolution, of rising temperature, large diameter and low density; the other late in evolution, of falling temperature, small diameter and high density. The former will give out many times more light than the latter, on account of their greater size; and the lower the temperature, the more marked will be the differences between these two classes. As contraction proceeds, the stars, whose angular momentum is large, will break up into pairs, those formed earliest having the longest periods. The farther evolution proceeds, the greater will be the proportion of such pairs among the whole number of stars. Periods less than a day or two can not arise unless the density is already near or beyond the critical value defined above. Recent work on spectroscopic binaries has shown that the proportion of these is greatest for type B and least for types K and M; that short periods, especially those less than two days, are practically confined to types B and A; that the systems which give evidence of unusually great mass are almost all of type B; that the relation between period and eclipse-duration among the Algol variables (which are almost all of types B and A) shows that their densities are of the "critical" order of magnitude; and that the distribution of proper motions among the stars of given apparent brightness and spectral type shows (as Herzsprung has pointed out) that the redder stars from type G onward fall into two groups: one remote, of small proper motion and great luminosity, the other near us, of large proper motion and small luminosity. These two groups overlap for type F, but are more and more widely separated for the redder stars. The stars of the first kind, being visible at great distances, form a disproportionately large percentage of the naked-eye stars—from 85 per cent. for type G to 100 per cent. for type M, for which even the nearest of the stars of the second sort are invisible to the naked eye. The following interpretation of these facts is suggested: assuming, as is now generally believed, that stars of type B have the highest surface temperature, and those of type M the lowest, it appears that the stars of type B show just the characteristics which the hottest stars might be expected to have, and that they represent a stage near the middle of evolutionary history; and that the two groups, of different luminosity, among the redder stars, agree in characteristics with those of rising and falling temperature predicted by theory. The former, stars of small proper motion, may be regarded as earlier in evolution, the redder they are; and the latter, stars of large proper motion, as later in evolution, the redder they are. Since most of the redder naked-eye stars belong to the former group, the small percentage and long periods of spectroscopic binaries among these spectral types are accounted for. The scheme of evolution here suggested is presented tentatively, as a working hypothesis. Its fundamental conception is similar to that underlying Lockyer's classification—from which,

however, it differs radically as regards the criteria for distinguishing rising and falling temperatures.

Results from Photographic Photometry: Edward S. King.

Early in the work the photometric laws were tested photographically; for example, the law of the square of the distance from the source of light was confirmed photographically by using various apertures. The law of the cosine for oblique rays of light was shown to be photographically valid up to inclinations of 60°. Beyond that point the intensity became less, possibly because of roughness of the film. The measures have all been made with a photographic wedge. Usually, three settings are made on each image; these are made at intervals some time apart. The average deviation of the wedge measures is about ± 0.05 magn. The wedge is capable of measuring small quantities; for example, a quantity known to be 0.03 magn. has been satisfactorily determined. One of the more important results was to show that a photographic plate is more sensitive when cold than when warm. At the same time the scale becomes less, so that the characteristics of a cold plate are changed to those of a faster emulsion. This is of special importance in winter, when plates may be taken from a warm dark-room and exposed in zero weather. It is the practise here to have all holders loaded in a cold outer dark-room, or left outside long enough to assume the external temperature before exposure. The effect of humidity is to decrease the sensitiveness. The so-called "time correction" has been investigated, and found to vary with the density of the image, the character of the developer, and other similar conditions. The light of the moon, sun and several planets has been determined. The light of the sky has been measured from noon to ten o'clock in the evening. The difference in brightness from day to night is about 17 magnitudes. The decrease at twilight is very rapid, amounting to 10 magnitudes in an hour. The measures of the bright stars have yielded perhaps the most important result, the relation of photographic and photometric magnitudes to the class of spectrum. The curve given in Vol. 59 of the *Harvard Annals* was based on about 110 stars. During the past year a redetermination of the magnitudes of the 33 stars discussed in No. 4 of Vol. 59 has been made. A supplementary list also has been observed, which brings the number of stars to 153. The latest results are included in the figure exhibited. These values give the means of finding the photographic magnitude with considerable accuracy, when the photometric magnitude and the class of spectrum are known. The average deviation of the individual stars from the curve is about ± 0.10 magn.

The method of obtaining magnitudes by photographing stars out of focus has been safeguarded so that there is little chance of grave error, except as may be caused by a change of conditions occurring during the period of exposure of any plate. This is in part eliminated by requiring that five measures of each star shall be made on five different nights. The distance at which the plate is set from the focal plane precludes the possibility of error arising from slight changes of focus. Since the approximate photographic magnitude is known in advance, it is possible to obtain images that match closely those of Polaris in density, thus making the scale of the plate of less importance. The method thus far used makes one exposure necessary for each star. Work on the Pleiades has been begun, using a brass plate having a number of apertures in it, so that each star shines through its own individual window to illumine the sensitive plate. Thus, a number of stars may be photographed simultaneously. Preparations have been made also to apply the method of out-of-focus images to the region of the pole. In order to obtain fainter stars the plate will be very near to the focal plane, and settings will be made inside and outside the focus in order to correct for change of focus, lack of flatness of the plate, and like sources of error. The great advantage of all these methods is that they give absolute values, and are free from many of the errors that usually beset photographic work.

A Unique Perturbation of Neptune: W. H. Pickering.

An examination of comet orbits led the author to suspect the existence of a large dark unknown body, located not far from the sun and in the general direction of the north pole of the ecliptic. Such a body should produce a peculiar perturbation of the outer planets, forcing them to describe smaller circles of the sphere, slightly to the south of their assumed orbits. To determine if this were the case a study has been made of the orbit of Neptune, based on the observations made at Paris and Greenwich. It was shown that from 1846 to 1873 the observations were well represented by Le Verrier's orbit and from 1882 to 1897 by that of Newcomb, but that Le Verrier's orbit would not represent the later observations nor the orbit of Newcomb the earlier, and sys-

tematic errors in latitude of from 1″ to 2″.5 were shown to exist in each case. Furthermore, it was demonstrated that it was impossible to represent both series of observations by any great circle. Since 1897 the planet has deviated farther and farther to the south from both of the computed orbits. The least deviation from the great circle, which would account for all the observations, was 1″, but a deviation of 2″.2 gave more concordant results. Uranus also gave indications of motion in an orbit well to the south of the great circle, but the deviation was too small both theoretically and practically to have much weight.

On the Light-curve of R T Persei: R. S. DUGAN.

The discussion of 14,000 photometric settings being nearly in final form, the following conclusions can be drawn: (1) The period is changing. (2) The apparent slight asymmetry of the light-curve is probably real. The greater part of this asymmetry is due to a cause other than eccentricity of orbit. (3) At the beginning and end of eclipse, the simple geometrical representation of the curve is a little unsatisfactory.

The Spectra of some Close Double Stars: ANNIE J. CANNON.

A large number of peculiar spectra are described in volumes 28 and 56 of the *Harvard Annals*. Forty-six of these were classified as composite, eighteen of which were found by Miss Maury. These composite spectra may be divided into two groups, according as the brighter spectrum is of an earlier or later class than the fainter. In thirty-two cases, the spectrum resembles that of a second or third type star, except that Hδ and Hγ are more intense and the band K, due to calcium, is fainter than normal. The two wide absorption bands, K and H, at wave-lengths 3934 and 3968, are marked features of classes G to M in spectra photographed with the objective prism. K is as wide, or wider than, H and any decrease in its intensity is readily noted. In some of these stars, as ϵ Carinæ, the band K is almost obliterated; in others, as 12 Comæ Berenices, it is about half as wide as the band H. On photographs of sufficient exposure, ultra-violet hydrogen lines Hη, Hθ, Hζ are seen as in spectra of types B to A5. It thus appears that the hydrogen lines are intensified and the calcium band is weakened by the superposition of a spectrum, which has stronger absorption of hydrogen and little or no absorption of calcium. Ten of these stars are known visual doubles, whose companions are close enough and sufficiently bright to cause the observed peculiarity of the spectrum. Eight are spectroscopic binaries: τ Persei, γ Persei, ζ Aurigæ, α Scorpii, δ Sagittæ, 31 Cygni, β Capricorni and α Equulei. Since α Scorpii is both a visual and spectroscopic double, it is uncertain to which companion the peculiar spectrum is due. It seems probable that there are at least seven spectroscopic binaries in which the two stars have widely separated classes of spectrum. Taking the known doubles from the list, there remain fourteen stars whose companions are yet to be observed. The following nine are brighter than the magnitude 5.50: H. R. 1129, f Persei, ϵ Carinæ, 12 Comæ Berenices, H. R. 5667, H. R. 7031, 6 Cygni, 47 Cygni and λ^3 Aquarii. Perhaps the most interesting case is that of 6 Cygni, which is the brighter component of the well-known double star β Cygni. The visual companion, whose spectrum is of class A, is photographed apart from that of 6 Cygni and, therefore, could not be the cause of any peculiarity due to superposition. The faintness of the absorption band K in 6 Cygni is well shown in the reproduction of this spectrum in Plate XI. of the "Atlas of Representative Spectra" by Sir William Huggins and Lady Huggins. Five measures of radial velocity which have been published by Küstner show no variation. However, in this case, as well as the others, it seems highly probable that additional observations will confirm the existence of a close companion.

Publications of the U. S. Naval Observatory in Press: W. S. EICHELBERGER.

Volume VI. will contain the observations made with the equatorial telescopes from 1893 to 1907: positions of satellites, diameters of planets and satellites, double stars, asteroids, comets, occultations, phenomena of satellites of Jupiter and Saturn, and transits of Mercury. This volume will also contain several appendices, as follows: the mass of Titan, the orbits of Deimos, Phobos and Enceladus, the solar parallax from observations of Eros, eighteen asteroid orbits, twelve comet orbits; miscellaneous observations of the transit of Mercury in 1894; and a catalogue of the publications of the Naval Observatory. Volume VII. will be a catalogue of the Washington Zones, 1846 to 1852, embracing about 45,000 observations on 23,518 stars. About 38,000 of these were reduced by nights and published thirty years ago; the remaining 7,000 now appear for the first time and a systematic search has been made for errors in the earlier reductions.

Solar Disturbances and Terrestrial Temperatures: W. J. Humphreys.

Observations appear to show that earth temperatures are greatest at times of sun-spot minima and least during spot maxima, and the natural inference is that there must be at these times corresponding differences in the solar constant, though such differences have not yet been observed through a spot cycle. At the time of spot maxima the solar corona is most extensive, and this must lead to a maximum in the scattering or diffusion of the radiation, and therefore to a minimum in the amount of short-wave light that reaches the earth, even though the total energy output may be the same. Now a change in the violet and ultra-violet radiation that reaches the cold dry oxygen in the upper atmosphere presumably alters the amount of this oxygen that exists in the form of ozone, in the sense that the greater this ozonizing radiation the greater the amount of ozone. Further, since ozone absorbs earth temperatures far better than the shorter wave-length solar radiations, it follows that when the ozone is in greatest abundance, or, as appears from the above, during spot minima, there must be an increase in earth temperatures. Temperature changes, therefore, that seem to indicate variations in the solar constant may be caused in part by changes in the spectral distribution of the sun's energy.

On the Solar Spectrum; Considerations based on a Study of Rowland's Tables: H. F. Newall.

On the Variations of the Cyanogen Band at Wave-length 3883: H. F. Newall.

Progress in Visual Observations of Variable Stars at the Harvard College Observatory: Leon Campbell.

The regular monthly observation of seventeen circumpolar variables of long period was begun in 1888. Sequences were selected, estimated and measured, and accordingly the magnitudes of the comparison stars were deduced on a uniform photometric basis. In 1892, fifty-six more variables, mainly of long period, were added to the list, and sequences for these were treated in a similar manner. Observations were made of these variables first by the method of Argelander and more recently by the method of direct estimates. The results of these observations up to 1906 are given in volumes 37 and 57 of the *Harvard Annals*. In 1904 the observing list was extended to include nearly all the variables of long period north of declination $-25°$, having a maximum brightness of 9.0 or brighter, and with a range of at least three magnitudes. More recently the above scheme has been extended to the southern sky, and over a hundred stars are included. For the ready and accurate identification and observation of these four hundred and more variables, maps have been made by enlarging sections of the charts of the Bonn Durchmusterung and photographs taken at this observatory; the excellent series of charts of Hagen and of the Yerkes Observatory have also been used. Twenty years ago an evening's work consisted of 15 to 20 observations, whereas now 50 and occasionally 75 are made; and the total number per annum has increased fivefold.

A Comparison of Magnitudes of Certain Stars in the Oxford and Potsdam Astrographic Catalogues and in the Cape Photographic Durchmusterung with Magnitudes on the Harvard Standard Photographic Scale: H. S. Leavitt.

Photographs and Spectrum of Halley's Comet: A. Fowler.

The photographs exhibited were taken by Mr. Evershed at Kodaikanal, India, the spectra having been obtained by the use of a prismatic camera of 2 inches aperture and 11½ inches focal length, with two prisms of 60°. The continuous spectrum of the nucleus crossed by Fraunhofer lines was clearly shown, together with the gaseous spectra respectively characteristic of the head and the tail. Fraunhofer bands of carbon and cyanogen were the chief features of the head, that of cyanogen at λ 3883 being especially intense, while the bands of the tail were essentially the same as those which appeared in Comets Daniel (1907) and Morehouse (1908). The author gave an account of the experimental work which had led him to identify the bands of the tail with the spectrum of carbon monoxide at very low pressures, and also to explain certain peculiarities in the carbon bands in the head by the superposition of a newly recorded "high-pressure" spectrum of the same gas.

Recent Results concerning Encke's Comet: Oskar Backlund.

Wave-length Formulæ for Series of Lines in Spectra: J. Rydberg.

Meteorological Observations in Connection with Halley's Comet: W. J. Humphreys.

This is a summary, made by Dr. Humphreys at the request of the comet committee of the society, of the atmospheric and other meteorological phe-

nomena at and around the time that Halley's comet was in transit on the sun, in this country and the West Indies. The chief material for this summary is the responses to a circular letter issued by the chief of the Weather Bureau to nearly two hundred of its observers. No magnetic or electric phenomena were noted that could reasonably be attributed to the comet. At many places, however, parhelia of unusual brilliancy and general appearance were seen; concerning these Dr. Humphreys concludes that "at present the possibility of the comet's influence in producing them can not be definitely excluded."

Report of the Committee on Luminous Meteors: CLEVELAND ABBE (chairman).

The chairman reported that, owing to his removal from Baltimore to Mount Weather, he had not been able to construct the apparatus for continuous photographic registration of the paths and times of bright meteors that pass within 45 degrees of the zenith. But this he expects to accomplish during the next year. The urgency of this class of work has been materially increased by recent theoretical memoirs on the composition, temperature and motions of the upper atmosphere. The success of such apparatus is assured by the recent work of Störmer, who has succeeded in obtaining a continuous series of instantaneous photographs of any portion of the aurora borealis at two neighboring stations; whence the altitudes are accurately determined just as it is expected to do in studies of meteors.

Report of the Committee on Comets: GEORGE C. COMSTOCK (chairman).

The work of this committee during the year has been concerned with observations of Halley's comet. The best methods of utilizing the present return were discussed by the committee and their conclusions were embodied in a circular letter that was widely distributed. The committee secured a grant of $2,200 from the Bache Fund of the National Academy of Sciences to defray the expenses of temporarily installing a photographic telescope in the Hawaiian Islands. Mr. Ferdinand Ellerman had charge of this expedition, and for this purpose he was courteously granted leave of absence by the Carnegie Institution. The committee is further indebted to the John A. Brashear Company and to the Lick Observatory for the loan of the portrait lens and its mounting. Mr. Ellerman succeeded in securing an extremely valuable record of the comet's appearance. He also made careful observations of the sun at the time when the comet transitted its disc, with wholly negative results, as was also the case at all other stations. Although the chances of success seemed small, the United States Weather Bureau undertook to secure from its observers reports as to any unusual atmospheric phenomena observed during or near the time that the earth was supposed to be passing through the comet's tail. For Dr. Humphreys's summary of these reports, as well as Mr. Ellerman's account of his activities in Hawaii, see their papers above.

The bill that is now pending in congress contemplating the appointment of a civilian head to the United States Naval Observatory was the subject of discussion both in the meetings of the council and in the general sessions of the society; as a result it was unanimously

Resolved: That the Astronomical and Astrophysical Society of America, deeming it essential to the success of an astronomical observatory that it should be under the direction of an eminent astronomer, expresses its appreciation of the efforts of the President of the United States to secure at the United States Naval Observatory this condition that has been found so effective in the great national observatories of other countries.

The officers elected for the ensuing year are: *President*, E. C. Pickering; *First Vice-president*, G. C. Comstock; *Second Vice-president*, W. W. Campbell; *Treasurer*, C. L. Doolittle; *Councilors*, W. J. Humphreys and Frank Schlesinger.

In response to a cordial invitation from Chief Astronomer King, it was decided to hold the next meeting at the Dominion Observatory in Ottawa, at some time next summer, the exact date to be fixed later by the president and the secretary.

Immediately after the close of the meeting many of those present started together on a journey across the continent for the purpose of attending the meeting of the Solar Union at Pasadena.

FRANK SCHLESINGER,
Editor for the Eleventh Annual Meeting

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 683d meeting of the society was held on November 5, 1910, President Woodward in the chair. The following paper was read:

On Gravity Determination at Sea: Dr. L. A. BAUER, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

On the "First Cruise of the *Carnegie* in the North Atlantic, which began at Brooklyn in September, 1909, and was closed at the same point in February of this year, determinations of the boiling point of pure water were made with the view of obtaining the necessary corrections to the aneroids aboard. Careful scrutiny of these observations gave the impression that with proper refinement in instrumental equipment and in method of observation, it would be possible to obtain data from which ocean gravity anomalies might be determined by the same method employed by Dr. Hecker in his cruises of 1901, 1904 and 1909—the so-called boiling point barometer method.

In order to determine wherein refinement was necessary and what the chief sources of error were, and their relative quantitative effects, the speaker made a careful review of previous ocean gravity observations. As a result of his combined study of the existing data and of the recent observations on the *Carnegie* he was led to the following conclusions on Hecker's ocean gravity work:

1. No wholly satisfactory measure of the absolute accuracy of the existing ocean gravity results can be secured by a mere perusal of the publications. If an independent examination is made and such checks applied as are possible, and when all sources of error are considered, it will not be surprising if it be found that many of the most recently published results are in error by an amount approximating to 0.1 cm. or about 1/10,000th part of g. In view of the pioneer nature of the work, opportunities presented for repeating observations, under different conditions, over regions previously traversed, should have been more fully embraced than was done.

2. One of the chief sources of error is to be ascribed to inconstancy of the corrections of the boiling point thermometers caused by their continued and protracted use; the error thus arising may at times transcend in importance all other ones. Not sufficient attention was paid to purely instrumental changes and corrections. Thus, for example, corrections for the boiling point thermometers of the Atlantic Ocean work of 1901 were used practically unaltered throughout the subsequent cruises of 1904 and 1909—after having been once supplied by the Physikalische Reichsanstalt, the corrections were never again redetermined. The belief that such purely instrumental changes would fully be taken account of in the adjustment is shown to be fallacious.

3. A source of error not considered is that due to possible imperfections of the vapor tension tables which must be used to convert boiling point temperatures into corresponding atmospheric pressures. An examination of the existing tables for the interval here under consideration, about 99° to 101° C., indicates that the errors of even the latest tables may at times be sufficient to cause an error in g of 0.1 cm. This error is not a constant one but varies with the boiling point temperatures; it is, hence, not wholly eliminated even in differential results.

4. Insufficient evidence has been given to prove that, in the reduction of the observations, it is best to omit those made on board vessels at anchor. A method of adjustment which already assumes practically what is to be proved, and which necessitates the rejection of data secured under supposedly the best conditions, weakening thereby the connecting link between the ocean results and the shore pendulum stations, can hardly be regarded as the best possible one. Instead some logical method of observation and of adjustment must be striven for which will take advantage to the fullest possible extent of the shore and harbor results.

5. The problem of sufficiently reliable ocean gravity results still awaits solution.

(The foregoing abstract was prepared by the author.)

R. L. Faris,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The second regular meeting of the session of 1910–11 was held on November 11.

The following papers were presented:

"The Electron Conception of Valence," K. G. Falk and J. M. Nelson.

"The Influence of Vapors on the Surface Tension of Mercury," Morris Loeb and S. R. Morey.

"Electrochemical Oxidation of some Hydrazine Salts" and "The Electrochemical Corrosion of some Metals in Sodium Trinitride," J. W. Turrentine.

Following these papers, Mr. Henry G. Pearson, editor of the *India Rubber World*, gave an illustrated lecture on "The Rubber Country of the Amazon."

C. M. Joyce,
Secretary